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UNITED STATES ARMY

HUMAN FACTORS RESEARCH & DEVELOPMENT

THIRTEENTH ANNUAL CONFERENCE

SPONSOR: CHIEF OF RESEARCH & DEVELOPMENT
DEPARTMENT OF THE ARMY

U.S. ARMY SIGNAL CENTER AND SCHOOL
FORT MONMOUTH, NEW JERSEY

OCTOBER 1967

461

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF RESEARCH AND DEVELOPMENT
WASHINGTON, D.C. 20310

CRDBES

SUBJECT: Thirteenth Annual Army Human Factors Research and Development Conference: Foreword and Transmittal

TO: SEE DISTRIBUTION

1. This report is the unclassified record of the 13th Annual Army Human Factors Research and Development Conference held at the US Army Signal Center and School, Fort Monmouth, New Jersey, 25-27 October 1967. The continued annual sponsorship of these conferences and the publication of this report by the Chief of Research and Development, Department of the Army, reconfirms the valuable contribution of the conference to the interchange of information among agencies and personnel concerned with the effectiveness of the US Army soldier, his training, and his equipment in the operational environment. A compendium of current Army human factors research and development work programs is included in the appendices of this report.

2. The conference successfully serves the vital functions of bringing together the diverse elements of the Army's human factors research and development activities and stimulating joint efforts on common problems. This year, the theme of the conference was "Enhancement of Human Performance for Military Operations."

3. The Army's Human Factors Research and Development Committee is to be commended for thoroughly planning and effectively conducting this successful conference. The committee is encouraged to continue its diligent and critical search for more effective means to assure that the Army derives full benefit from the application of the results of research in the psychological and social sciences. Comments regarding this conference may be directed to the Chief of Research and Development, ATTN: Chief, Behavioral Sciences Division, Department of the Army, Washington, D.C. 20310.

FOR THE CHIEF OF RESEARCH AND DEVELOPMENT:

Charles D. Y. Ostrom, Jr.

1 Incl
Report

CHARLES D. Y. OSTROM, JR.
Brigadier General, GS
Director of Army Research

CRDBES
SUBJECT: Thirteenth Annual Army Human Factors Research and Development Conference: Foreword and Transmittal

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REPORT OF THE THIRTEENTH ANNUAL
U. S. ARMY HUMAN FACTORS RESEARCH AND DEVELOPMENT CONFERENCE

25-27 October 1967
U.S. Army Signal Center and School
Fort Monmouth, New Jersey

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U. S. Army Chief Psychologist
Office of the Chief of Research and Development
Department of the Army, Washington, D. C. 20310

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C. SPONSOR'S CHARGE: Austin W. Betts, Lieutenant General, USA, Chief of Research and Development, Department of the Army, Washington, D.C. 20310

U.S. ARMY REQUIREMENTS FOR THE HUMAN FACTORS RESEARCH AND DEVELOPMENT PROGRAM

Chairman: Charles Hersh
Office of the Deputy Chief of Staff for Personnel
Department of the Army
Washington, D.C. 20310

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E. THE ARMY 75 PERSONNEL CONCEPT: James A. Thomas, Office of the Deputy Chief of Staff for Personnel, Department of the Army, Arlington, Virginia 22202

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G. NEW TECHNIQUES IN MOS DEVELOPMENT: Warren P. Davis and Harry I. Hadley, Office of Personnel Operations, Department of the Army, Washington, D.C. 20315

H. MATERIEL LIFE CYCLE MANAGEMENT MODEL: W. C. Lowry, Jr., Lieutenant Colonel, USA, Office of the Assistant Chief of Staff for Force Development, Department of the Army, Washington, D.C. 20310

I. COMBAT DEVELOPMENTS COMMAND REQUIREMENTS: Seymour Goldberg, U.S. Army Combat Developments Command, Fort Belvoir, Virginia 22060

J. RESEARCH IN SUPPORT OF PSYCHOLOGICAL OPERATIONS: Louis A. Waple, Colonel, USA, U.S. Army Special Warfare School, Fort Bragg, North Carolina 28307

REPORT OF THE THIRTEENTH ANNUAL U. S. ARMY HUMAN FACTORS RESEARCH AND DEVELOPMENT CONFERENCE

1.A. BACKGROUND

References:

a. Conference Report, "Army Human Engineering Conference," The Pentagon, 14-15 December 1955.

b. Report, "Second Annual Army Engineering Psychology Conference," Army Medical Research Lab. Fort Knox, Kentucky, 7-9 November 1956.

c. Report, "Third Annual Army Human Factors Engineering Conference," Quartermaster Research and Engineering Command, Natick, Massachusetts, 2-4 October 1957.

d. Report, "Fourth Annual Army Human Factors Engineering Conference," U.S. Army Chemical Center, Maryland, 9-11 September 1958.

e. Report, "Fifth Annual Army Human Factors Engineering Conference," Redstone Arsenal, Alabama, 22-24 September 1959.

f. Report, "Sixth Annual Army Human Factors Engineering Conference," Fort Belvoir, Virginia, 3-6 October 1960.

g. Report, "Seventh Annual Army Human Factors Engineering Conference," University of Michigan, 3-6 October 1961.

h. Report, "Eighth Annual Army Human Factors Engineering Conference," U.S. Army Infantry Center, and U.S. Army Infantry School, Fort Benning, Georgia, 16-19 October 1962.

i. Report, "Ninth Annual Army Human Factors Research and Development Conference," Walter Reed Army Medical Center, Washington, D.C. 14-17 October 1963.

j. Report, "Tenth Annual Army Human Factors Research and Development Conference," U.S. Army Aviation Center, Fort Rucker, Alabama, 5-8 October 1964.

k. Report, "Eleventh Annual Army Human Factors Research and Development Conference," U.S. Army John F. Kennedy Center for Special Warfare, Fort Bragg, North Carolina, 3-6 October 1965.

l. Report, "Twelfth Annual Army Human Factors Research and Development Conference," U.S.

Army Infantry Center, Fort Benning, Georgia, 2-5 October 1966.

m. Army Regulations 70-8, Human Factors and Nonmateriel Special Operations Research, dated 19 November 1965.

Sponsorship and Planning of the Conference:
The annual U.S. Army Human Factors Research and Development Conference is sponsored annually by the Chief of Research and Development, (OCRD) Department of the Army. This conference is the Thirteenth in the series. The conference includes programs in all areas of human factors research of interest to the Army.

Previous conferences have been reported in references a through l above.
In accordance with references, planning for the conference, as well as follow-up of its suggestions and recommendations, is accomplished by a U.S. Army Human Factors Research and Development Committee (formerly the Army Human Factors Engineering Committee) The committee is composed of representatives of the Chief of Research and Development (Chairman), the U.S. Continental Army Command, U.S. Army Combat Developments Command, U.S. Army Materiel Command. In addition to the above representation directed by reference l, the committee has been augmented since 1960 by regular participant observers from the U.S. Army Behavioral Science Research Laboratory, a Class II activity under the jurisdiction of OCRD; the Human Resources Research Office (HumRRO), of The George Washington University and the Center for Research in Social Systems, The American University.

Purposes of the Conference are:
a. To provide direct exchange of information on human factors research and development among personnel of U.S. Army development agencies and between these and representatives of user agencies and other qualified individuals.
b. To provide recommendations and suggestions to be followed up by the U.S. Army Human Factors Research and Development Committee to assure exploitation of all opportunities for improving the effectiveness of the U.S. Army soldier, his training and his equipment.
c. To provide a conference report which will serve as a useful, authoritative, and complete compendium of current work programs and related information concerning all U.S. Army human factors research and development activities.

Following the invocation by Chaplain (Lieutenant Colonel) William A. Watson, the Conferees were welcomed by Brigadier General Thomas M. Rienzi, Commanding General, U.S. Army Signal Center and School. Following the welcoming remarks, Lieutenant General Austin W. Betts, Chief of Research and Development, Department of the Army, delivered his Sponsor's Charge to the Conferees. The Charge urged the behavioral scientist to develop and vivid and realistic understanding of the military operational objectives to be served by his research. General James K. Woolnough, Commanding General, U.S. Continental Army Command, in his keynote address, emphasized in terms of CONARC's current and future needs the urgency of assuring that useful

products of behavioral and social science research be put promptly to work in Army operational use.

The Conference Banquet was held on the evening of 25 October 1967. Dr. Donald M. MacArthur, Deputy Director (Research and Technology), Office of Director of Defense Research and Engineering, was not able to deliver his address because of illness. Brigadier General Charles D.Y. Ostrom, Jr., Director of Army Research, Office of the Chief of Research and Development, and Brigadier General Thomas M. Rienzi, the host, spoke at the banquet. They emphasized that social and behavioral scientists must educate not only the elements of the Army, which are concerned with human performance, but also the academic community, industry, the U.S. Congress, the Department of Defense, and society at large, and to "do it with enthusiasm."

Chairman's Summary and Recommendations

The Conference objective: direct exchange of information on plans, problems, and accomplishments between the "doers" and the "users" of behavioral and social science research on the enhancement of human performance in military operations. The goals and dimensions of research are necessarily somewhat different from the goals and dimensions of operations: "Give me better students for helicopter training"; "Give me better training programs"; "Tell me how to measure performance." But these needs are stated in terms too general to serve as the basis of formulation of research. This is the area where coupling-real eye-ball to eye-ball discussion-between the users and the researchers is critical for specificity and responsiveness. Conference Sessions I & III review current and future plans and requirements from the users point of view, and clarify for both the distinctions between research objectives and the operational objectives they support. General Woolnough's Keynote address emphasizes CONARC's current and future needs and urged that useful products of behavioral and social science research be put promptly to work in Army operations. General Betts charges the behavioral scientists to develop a realistic understanding of the military operations supported by their research. Current and future plans and requirements are presented in detailed papers from OCRD, ODCSPER, OPO, HCSFOR, USACDC, and JFK Center for Special Warfare. Session II presents specifics of Army operational requirements of Automatic Data Field Systems Command and recent relevant behavioral science research results. Session IV papers and discussions provide a fuller understanding of selected social science problems whose solutions will significantly assist Army operations overseas. Session V describes the systems approach to problems of technical training employed at the Signal School, and provides detailed demonstrations. Session VI identifies major problems in the design and evaluation of man-machine systems, and presents methods of solving these in design and concept definition phases. Discussions in Session VII evidence clear and improved appreciation by all participants of the Conference objectives and the relevance of the Conference papers.

Forecast: Progressive involvement of behavioral and social sciences in entire spectrum of RDT&E from 6.1, Research, through

6.5, Studies and Analyses. Greater pay-off, especially through increase of behavioral and social science "technologies" and "technologists" (currently scarce). Progressive clarification and specification of military presence and of military force. Progressive reduction of selection standards for training to acceptable degrees of readiness for mobilization for engagements of force. Progressive raising of standards of professional military manpower distribution, assignment, and retention for the measured application of military presence.

The conference adjourned at 1200 hours, 27 October 1967.

1B. ADDRESS OF WELCOME

Thomas Matthew Rienzi, Brigadier General, USA
Commanding General
U.S. Army Signal Center and School
Fort Monmouth, New Jersey 07703

Mr. Chairman, General Betts, distinguished members of the conference, ladies and gentlemen:

Thank you Dr. Baker for that fine introduction. As Commandant of this great School - of which I am deeply proud - I assure you that it is indeed an honor and a privilege to welcome you as host for this most important conference.

The conference theme - "Enhancement of Human Performance in Military Operations" - is not new, nor is it a particularly noble theme. For example, it would be nobler if it were addressed to the enhancement of human performance in peaceful pursuits. However, it is a purpose to which all of us in this distinguished audience must dedicate ourselves in this moment of history. How well we succeed in our collective efforts may eventually determine whether we will survive as a Nation, or whether our way of life will disappear with the other great civilizations of the past.

Last February, I wrote to General Betts, assuring him of my wholehearted support of the conference, and stating that I was totally in accord with his premise that progress in satisfying Army requirements is greater when scientists and professional soldiers have an opportunity to meet together and exchange views. This is one of our purposes for being here today. With the knowledge explosion engulfing all areas of human endeavor, and our technology advancing forward at an ever-increasing rate, there is no doubt that much valuable research is overlooked because it is not produced in useable form or in timely fashion for Army use. It appears to me that this condition may exist to an even greater degree in the psychological and social sciences where the applications of new knowledge gained through research are not quite so apparent as in the physical and biological sciences. Personally, I believe that the Army has much to learn in the application of human factors to

military operations and, conversely, much to give.

Looking over the list of attendees it is apparent that many others apparently share my views as to the desirability of convening a Human Factors Conference. Present here today are representatives from the Office of the Secretary of Defense, Department of Army Staff Agencies, major Army commands, Air Force, Navy, Marine Corps, research laboratories, industry, and military representatives from several allied nations.

It is my privilege at this time to introduce to you several of our more distinguished guests. Dr. Baker will introduce our next speaker - Lieutenant General Austin W. Betts, Chief of Research and Development, Department of the Army. Tomorrow, my Boss, General James K. Woolnough, Commanding General, United States Continental Army Command, will deliver the keynote address.

(Note: General Rienzi introduced distinguished conferees.)

As your host, I should like to take this opportunity to inform you of several interesting programs and events which have been arranged in your honor.

Today and tomorrow, you will be guests of the US Army Signal Center and School at a luncheon in one of our troop messes which is located directly across the street to the rear of this auditorium. Tonight, of course, is the conference banquet at the Hotel Berkeley-Carteret in Asbury Park, starting promptly at 7:30 p.m. Also, we would like to meet all of you during the social hour, which begins one hour earlier, at 6:30 p.m. Your ticket of admission to the luncheon and banquet will be your conference badge. Please wear it at all times, including the Honor Guard Ceremony for General Woolnough.

During the host session tomorrow afternoon, we will show you some of the exciting things we are doing educationally at the Signal School. The presentations are centered around the information contained in the orange-colored booklet entitled "A Systems Approach to Training" - which each of you received in your registration packet. Following the formal presentations in this auditorium, it would please me very much if all of you would join us on a tour of various training facilities located here in the Myer Hall complex. From these presentations and tours, I am sure each of you will gain a deeper understanding and appreciation of the efforts being made by Army service schools to produce the most capable soldier and technician in the least amount of time.

Tomorrow evening - Thursday evening - it is my pleasure and privilege to invite you to attend a performance of the "Up With People" program which will be held in the Fort Monmouth Field House beginning at 7:30 p.m. Although there will be a full house, a section of the bleachers has been

reserved for the conferees. So please wear your badge. Bring your wife if she is with you. Special buses will transport you from the hotel, leaving at 6:45 p.m. For those of you who are driving in private automobiles, I would suggest you arrive early because parking space will be at a premium.

I am sure some of you have either heard or read of this program. It is a songfest put on by a regional group of singers, sponsored by Moral Re-Armament, Incorporated. Its aim is to involve youth and adults in a community action program to rebuild family life and enhance the best traditions of the Nation. "Up With People" casts have been on national television and have presented shows at over 300 colleges and schools, the four service academies, 89 military bases in the United States and overseas, and have been the guests of other governments. I know you will enjoy the show.

It is my sincere hope that when the conference adjourns on Friday, each of you will have gained something of value to take home with you, and that you will have pleasant remembrances of your visit to the US Army Signal Center and School.

Thank you!

1C. SPONSOR'S CHARGE

Austin W. Betts, Lieutenant General, USA
Chief of Research and Development
Department of the Army
Washington, D.C. 20310

1. The theme of this Conference is "The Enhancement of Human Performance in Military Operations."

2. Last year in my charge to this conference I said:

a. That the Army places great value and high priority on the technologies which the behavioral and social sciences are developing to improve our skill in handling the human factors in military operations;

b. And, as Chief of Research and Development, I earnestly solicited your assistance to produce a continuously improved understanding in DOD and the Congress of this Army need.

3. This year I want not only to reaffirm that charge, but to go one step beyond it: I want to impress upon you the necessity that you yourselves, apart from the degree of understanding achieved at higher levels, must at all times vividly and clearly understand the military operational objectives which must be served by your work in the behavioral and social sciences.

4. Why does the Army want to reaffirm the high evaluation and urgent priority it places on your work? Because:

a. We know, as I told the Army Conference on Maintainability only this September, that our nation suffers when some of our most costly and important hardware systems may be prematurely phased out after a heavy development investment. Some of these phase-outs must occur, not because the system is obsolescent, but because the Army cannot afford the steeply accelerating costs of operating and maintaining them.

b. We know, from our experience with the technologies now being developed by the behavioral and social sciences, that you can help reduce this burden.

5. In recent years we have seen increased complexity not only in the guided missiles, jet aircraft, intercontinental communications networks and computers which we now have, but also in the increased sophistication of such familiar systems as trucks, rifles, and field pieces. It is easy to decry such complexity, but there is little likelihood that the trend will reverse.

6. In recent years, support costs have constituted eleven percent of the defense budget. These support costs include not only the expenses of repair parts, special

tools and equipment, and the maintenance float, but also personnel and training costs. One unhappy instance experienced by the Army saw support costs total 1500 percent of the materiel's acquisition price. Sometimes, of course, an improvement in metallurgical or electronic technology, for instance, may overcome the difficulty. But reaching beyond this we need improved technology for "The Enhancement of Human Performance in Military Operations" (conference theme) to improve the human components of these complex systems.

7. That's why we reaffirm the conviction expressed last year to this Conference.

8. But the technology for "Enhancement of Human Performance in Military Operations" will not be rapidly developed unless you yourselves, the behavioral and social scientists whose research develops that technology and the management officials who program and support the research, vividly and clearly understand the military operational objectives to which your science is relevant.

9. I am therefore pleased to see that this Conference will again devote serious attention to those military operational objectives. Your discussions in this Conference will, I am sure, go far to spell out and clarify those objectives to the great benefit of future planning and R&D program support.

10. I charge you to get on with the job.

1D. U.S. ARMY OPERATIONAL REQUIREMENTS FOR BEHAVIORAL SCIENCE RESEARCH AND DEVELOPMENT

Lynn E. Baker
U.S. Army Research Office, OCRD
Department of the Army
Washington, D.C. 20310

FOREWORD

Since we are dealing here specifically with the behavioral sciences, and we include in this term (and have frequent occasion to refer to) social sciences, it is well to begin by stating a clear and generally acceptable definition of these terms. Webster's Third New International Dictionary (G. and C. Merriam, Springfield, Mass., 1967) provides such generally accptable definitions as follows:

"behavioral science n: a science (as psychology, sociology, or anthropology) dealing with human action and aiming at the establishment of generalizations of man's behavior in society." (Page 199)

"social science n: 1: the branches of science that deal with the institutions and functioning of human society and with the interpersonal relationships of individuals as members of society. 2: A science (as economics or political science) dealing with a particular phase or aspect of society." (Page 2162)

The terms behavioral science(s) and social science(s) are used in this paper in accordance with the above definitions, and those definitions are recommended for acceptance in the Army.

Full understanding of current Army programs and mid- and long-range planning for research and development in the behavioral and social sciences entails an appreciation of the elements and their relations diagrammed in figure 1.

a. The context of U.S. national goals in which long range Department of Defense planning is embedded, and the Joint Chiefs of Staff objectives which, within these national goals, provide broad program boundaries for the several military services;

b. The Army Research Plan (ARP) which, consistent with the Army's Basic Strategic Estimates (BASE) and the Army Strategic Plan (ASP), Furnishes the immediate guide lines for program planning within the broad disciplines of the behavioral and social sciences; and

c. The nature of the relation-

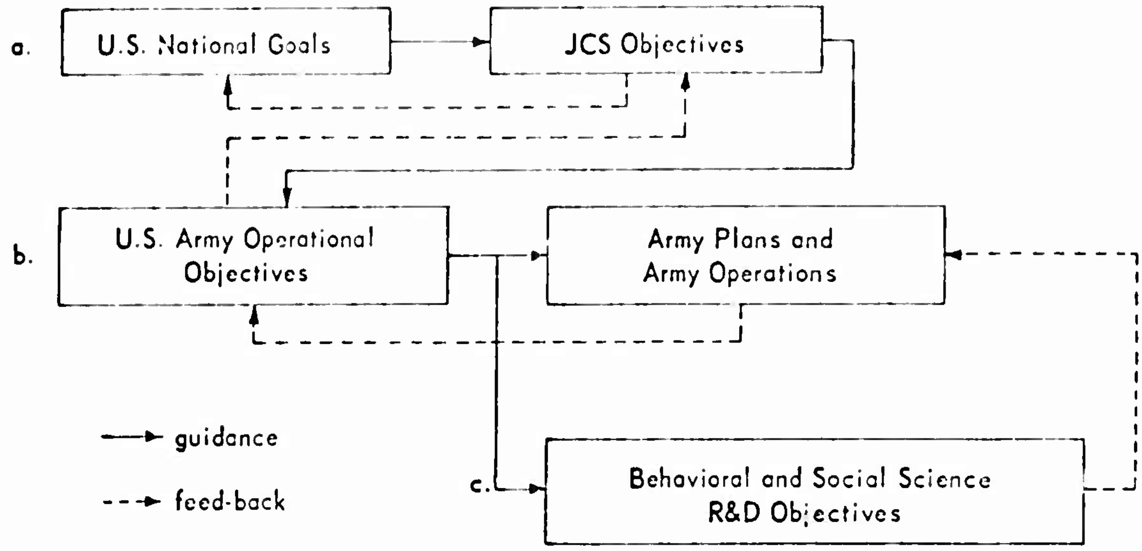


Figure 1. Elements of Appreciation of Army Behavioral and Social Science R&D Programs

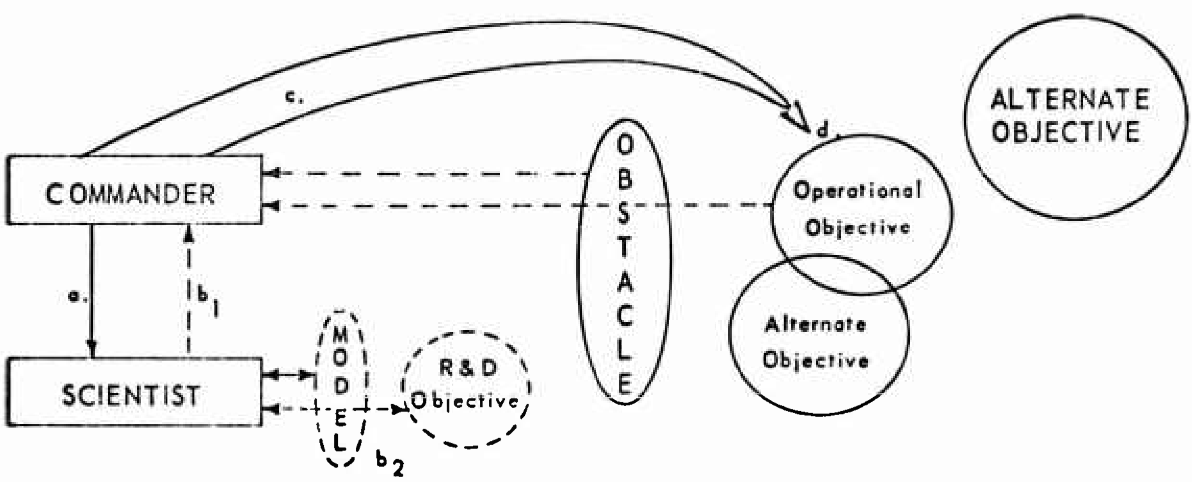


Figure 2. Relations, and Distinction, between Operational and R & D Objectives:

ship, and the distinction, between operational objectives and research objectives.

Let us first briefly examine in detail the regenerative loop between operational objectives and operations (level b in the figure) and behavioral and social science R&D objectives (level c in the figure).

APPRECIATION OF RELATIONS, AND DISTINCTION, BETWEEN OPERATIONAL AND RESEARCH OBJECTIVES

We begin this examination by noting that the dictionary definition of appreciation is: "to set a just value on." It is essential to our understanding that we set a just value on the distinction between operational objectives and research objectives, for although they are related they are not identical. The distinction, and the important consequences which flow from the distinction, is expressed by the following example and diagrammed in figure 2.

a. Assume that an operating official (commander in figure 2), a man who has been assigned command responsibility for an operational decision, has a problem and seeks the help of a scientist (e.g., a mathematician) to find a solution.

b. The scientist (e.g., the mathematician) in this situation may know a solution for the operational problem. In this case he simply refers the operator to the particular relevant established technology (b in figure 2), and the episode is complete with no requirement for research. We shall have occasion to refer later in this discussion to the formation of a technology in this sense--the formation of a body of knowledge or methods which can be directly applied to the solution of operational problems without the necessity for research discovery.

c. In certain important cases, however, the scientist (e.g., the mathematician) may have no satisfactory available technology to which to refer the commander. In this case, please note, he does not ordinarily offer to solve the operator's problem. Instead, he presents, and offers to seek a solution to, a different problem (b_2 in figure 2). This different problem, the research problem, or model, if you please, has the following two properties:

(1) it appears to resemble the operational problem, at least in certain stateable particulars; and

(2) the scientist (e.g., the mathematician in our example) knows a method of attack which he considers may yield a solution.--This, mind you, will be a solution to the research problem, which may bear stated relations to, but is not, the operational problem. The solution of the model problem may bring with it one or more alternate objectives for the commander's consideration.

d. It is a matter of great practical importance for both the scientist and the operator to recognize that the episode is not yet complete, as it was in the case in which a relevant technology was available for reference. To complete the episode, the operator must make one or more decisions--one or more choices among alternatives as outlined in figure 3.

(1) If the operator agrees (has faith) that the research problem sufficiently resembles the operational problem to (a) yield a

degree of assistance to its solution, (b) while the operational problem still exists (or is likely to recur), he (c) identifies the solution of the research problem as a valid research objective (i.e., a research objective which supports an operational objective) and determines that the problem presents a valid research requirement. Alternatively, he may terminate the episode at this point by determining that one or both of these conditions are not met by the research problem.

(2) If the operator validates the research requirement, further decisions are necessary to determine its priority for the allocation of resources. Regardless of these decisions, however, the episode is not completed until:

(a) the research requirement has been satisfied and

(b) the operational requirement has received such assistance as the developed technology can afford.

NATIONAL GOALS AND JOINT CHIEFS OF STAFF GUIDANCE

In the pluralistic society of which the U. S. Army is an integral part, national goals are necessarily complex in the broad view, and obscure as to their fine details. Nevertheless, the major categories of national goals can probably be agreed in general to include the sixteen general areas listed in figure 4. which were accepted by the National Planning Association's 1965 paper entitled "The Dollar Costs of Our National Goals." by Leonard A. Lecht. The same sixteen broad areas were cited by President Eisenhower's Commission on National Goals as being areas in which the nation appears to have set higher levels of achievement for itself. It is sufficient for our present purposes to note concerning this list that the sixteen areas cited by President Eisenhower's Commission on National Goals include a number which relate to Army programs in the behavioral and social sciences; e.g., No. 8, National Defense; No. 10, Research and Development; No.12, International Aid; and No. 15, Manpower Retraining.

Joint Chiefs of Staff Objectives, to the achievement of which the behavioral and social sciences can make significant contributions, are stated in certain classified documents (here paraphrased for discussion in the clear) under two headings: Human Factors and Personnel Support, and Social Sciences.

Under the general heading Human Factors and Personnel Support, these documents present the eleven objectives which are listed below under categorical headings to be discussed later. (Some recur under more than one heading.)

QUALITATIVE AND QUANTITATIVE MANPOWER RESOURCES AND REQUIREMENTS

"a. Improved means of accurately determining and projecting manpower requirements both qualitatively and quantitatively........

"b. Improved techniques for the rapid and efficient mobilization of our national manpower....."

SYSTEMS FOR PERSONNEL ACCESSION AND DISTRIBUTION

"b. Improved techniques for the rapid and efficient mobilization of our national manpower....."

"c. Significant improvement in the systems for the procurement,

training, assignment, and management of military personnel.......

"d. Development of improved techniques and tools for the selection, classification, and utilization of personnel........"

PERFORMANCE MEASUREMENT

"e. Establishment of better methods for objective evaluation of individual performance.

"h. Development of advanced simulators and simulation techniques, both as training devices and as performance evaluators."

BASIC AND ADVANCED INDIVIDUAL TRAINING

"f. Development of improved training techniques and methods.... particularly in technical fields which require extensive training.

"g. Development of improved leadership training techniques and leadership capabilities at all echelons........

"h. Development of advanced simulators and simulation techniques..."

MAN/MACHINE COMPATIBILITY

"i. Application of human factors technology to equipment development.....(for) man-machine compatibility........of operation and maintenance.....

"j. Improved means for quantifying behavioral and social science elements of human factors technology to provide base-line data for equipment developers."

BASIC RESEARCH IN THE BEHAVIORAL SCIENCES

"k. Extension of knowledge concerning the fundamental psychological, physiological, sociological, and biomechanical factors which influence human behavior."

SOCIAL SCIENCES

Under the general heading Social Sciences, the Joint Staff guidance presents objectives substantially as follows:

"Techniques to aid in assessing the level of social unrest in various societies and the trend of unrest existing in the many possible areas of conflict. Research should be directed toward linking measures of those parameters which are likely to be indicative of qualitative (mathematical) degrees of unrest... Research should be conducted to determine ways to produce an understanding by the mass of Free World citizens of the role of military power in securing their freedom, institutions, and existence. Emphasis should be placed on aiding development of sound, intelligent, and realistic public attitudes, and on avoidance of attitudes developed through misunderstanding and emotional involvement which can be manipulated by a skilled enemy to produce a significant Free World military disadvantage."

MAJOR FUNCTIONAL CATEGORIES OF U.S. ARMY OPERATIONAL OBJECTIVES AND RELATED BEHAVIORAL AND SOCIAL SCIENCES OBJECTIVES AND REQUIREMENTS

The above-summarized operational objectives are in the very general terms befitting broad national guidance at the levels of the Department of Defense and the Joint Chiefs of Staff. We must now narrow our discussion to the level more specifically appropriate to the U.S. Army's roles and missions. The Office of the Chief of Research

1. MAJOR CRITERIA FOR VALIDATION:
   a. "Resemblance" ("relevance") of model to operational situation.
   b. Liklihood of reaching model solution in stated operational time.

2. MAJOR CRITERIA FOR ESTABLISHMENT OF PRIORITY:
   a. Resources available in consideration of other requirements.
   b. Relative costs and effectiveness of alternatives.

Figure 3. Basic Properties of Criteria for Mission-Oriented R&D Validation and Priorities.

NATIONAL GOALS – HIGHER LEVELS OF ACHIEVEMENT IN:

1. Consumer Expenditures and Savings
2. Private Plant and Equipment
3. Urban Development
4. Social Welfare
5. Health
6. Education
7. Transportation
8. National Defense
9. Housing
10. Research and Development
11. Natural Resources
12. International Aid
13. Space
14. Agriculture
15. Manpower Retraining
16. Area Redevelopment

Figure 4 List of Major Areas in Which Higher Levels of Achievement are Sought as National Goals.[1]

[1]Adopted for National Planning Association paper, "The Dollar Costs of Our National Goals," by Leonard A. Lecht (1965); extracted from reports of President Eisenhower's Commission on National Goals.

MAJOR FUNCTIONAL CATEGORIES OF U.S. ARMY OPERATIONAL OBJECTIVES

1. Qualitative and quantitative manpower resources and requirements
2. Systems of personnel accession and distribution
3. Systems for individual training
4. Unit performance measurement and training
5. Training for leadership and command
6. Training technology and training management
7. Performance capabilities measurement and evaluation
8. Man/machine compatibility in materiels design
9. Support of military operations in developing nations

Figure 5. Categories of Military Operational Objectives to which Behavioral and Social Science R&D are Relevant.

QUALITATIVE AND QUANTITATIVE MANPOWER RESOURCES AND REQUIREMENTS

OPERATIONAL OBJECTIVE	RESEARCH REQUIREMENT
Provide, for Army personnel and force-structure planning, precise qualitative and quantitation information on:	a. Construct qualitative and quantitative inventory of resources
a. Current and projected manpower resources under various stated conditions of threat mobilization policy U.S. economic and technical advance	b. Evaluate the fit of inventoried resources to force-structure alternatives for each stated condition of threat, etc.
b. Do for probable allies and friendly nations	c. Identify major parameters for specification of rational system(s) for optimum qualitative and quantitative manpower assignment and distribution.
c. Fit of above to manpower requirements for ultimate optimum manpower resources distribution.	

Figure 6. Operational Objective, and a Suggested Research Requirement, for Manpower Research.

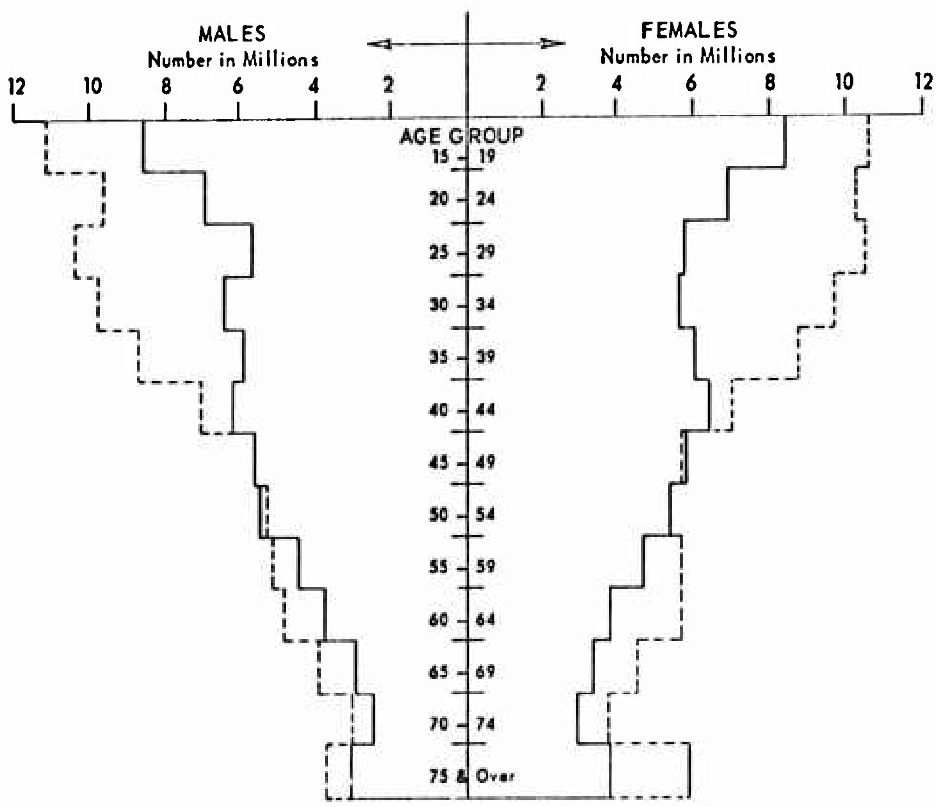


Figure 7. Age, and Sex Composition of U.S. Populations 15 Years of age and Older in 1965 (Estimated) and 1985 (Projected)*

* Source: Table 4, Current Population Reports *Population Estimates*, Series P-25 No. 345, July 29, 1966, U.S. Dept. of Commerce, Bureau of the Census

and Development annually sends a "dragnet" letter to all General Staff elements and Major Commands. The letter requests these staff and command activities to identify problems of human factors in military operations concerning which behavioral and social science research and development might be of assistance. The major portions of the U.S. Army Human Factors R&D programs, especially in the Behavioral Science Research Laboratory (BESRL), the Human Resources Research Office (HumRRO), and the Center for Research in Social Systems (CRESS) have been formulated for the past several years in response to the replies to this "dragnet" inquiry.

U.S. Army experience over these years, increasingly reflected in such Army planning guidance documents as the Basic Strategic Estimate (BASE), the Army Strategic Plan (ASP) and the Army Research Plans, has shown that the behavioral and social sciences have their major relevance to the nine categories of operational objectives listed in figure 5. These categories are now being considered to form the framework or skeleton on the basis of which our 5-year Behavioral and Social Science research plan is currently being developed. Each of the major categories of course can be, and is, further analyzed into sub-categories of operational objectives. A major purpose of this analysis is to find a specific statement of objective such that either:

a. An available technology can be recommended to assist achievement of the objective, or (in the absence of such)

b. A research objective can be stated which is foreseen to have the properties of <u>relevance</u> and <u>promise of solution</u> described earlier in this paper.

To summarize the argument to this point: (a) the objective of our plans is, "The Enhancement of Human Performance"--specifically, the improvement of human factors in military operations; (b) our assigned task is to exert the capabilities of the behavioral and social sciences to that end.

The following paragraphs provide examples to show how stated Army operational objectives relate to specifiable behavioral and social science requirements.

QUALITATIVE AND QUANTITATIVE MANPOWER REQUIREMENTS

The operational objective in the manpower resources and requirements area is stated in the left column of figure 6. The objective is to provide Army planners with information on military manpower resources and military manpower requirements. A promising and "attainable" research objective, or requirement, is stated in the right-hand column of the figure.

The manpower functional category of operational objectives has for some time had relatively little R&D attention in Army or U.S. Department of Defense programs. Indeed, aside from the established and critically essential inquiries of the U.S. Census Bureau and the Bureau of Labor Statistics, only the Office of Education/American Institutes of Research Project TALENT comes immediately to mind as one initial reconnaissance in force. Some may therefore not be acutely aware that there is technology available for acceptably precise specification of future manpower resources in quality as well as in quantity. I have therefore prepared, from U.S. Census

data, a quick and technically simple projection in figure 7. It gives a broad and preliminary example of the kinds of questions which may well deserve the attention of Army manpower planners. I am confident that the behavioral and social sciences are able to find answers to these questions within acceptable limits of error.

The two-sided bar-histogram in figure 7 presents a familiar comparison, by sex(males at the left, females at the right), of the age distribution of the U.S. population over 14 years of age in 1965 (heavy lines) and in 1985 (dashed lines). All of these people have already been born. This fact simplifies our problem but is not essential to a solution. It is a further fact that almost all of them, in 1967, are already eligible to vote. Examination of this analysis quickly demonstrates that there will be almost 15 million more males and over 15 million more females in the U.S. population in 1985 than we had in 1965 between the ages of 15 and 44. It is not surprising, then, that Bureau of Labor Statistics studies over the past decade and more have usually reassured us that we do have sufficient manpower resources to meet expected future military manpower requirements.

However, the chart does ask the Army Deputy Chief of Staff for Personnel, the Assistant Chief of Staff for Force Development, the Commanding General of the U.S. Continental Army Command, and the behavioral and social science community as a whole a few interesting, and some grisly, questions which I believe can be answered if they are important enough to warrant the expense of obtaining the answers:

a. Within the age-structure shown for 1985, what will be the distribution of educational attainments of these voters? Of their occupation and industry experience in production of goods and services, urban and rural? And incidentally, what proportions will already be veterans of Vietnam types of conflict? In a related connection, I have heard Dr. Craig Crenshaw, AMC Chief Scientist, quote Mr. K. T. Keller, former Chairman of the Board of the Chrysler Corporation, and distinguished long-term member of the Army Scientific Advisory Panel, as saying, "The maintenance technicians of World War II were drafted from American Industry. Modern industrial methods and organization in the U.S. today provide no such supply." If you don't believe this, just try nowadays to find a good, all-round auto mechanic.

b. A second group of questions:

Assuming an unannounced nuclear attack on the Continental United States, what will be the age and sex distribution of the casualties in that attack, and of the residual manpower pool afterward? What migration patterns, in that event, would be necessary in the U.S., and would eventuate on this continent? What age and sex characteristics, and what modifications of training and military operations doctrine would be most feasible, most necessary?

These are only an illustrative few of the questions which the histogram asks of the U.S. Army General Staff.

c. Finally, the figure also presents a number of other points.

For instance, it shows in 1965 an estimated 8 million 2 hundred thousand females aged 15 to 19 in 1965. By 1985 these ladies will all, of course, have aged 20 years and will be 35 to 39 years of age--all, that is, who haven't been eliminated from the population by, e.g., death. Now look at the number of females the chart predicts will be in the 1985 population at age 35 to 39. The 8.2 million teen-age girls in 1965, the chart says, now become 8.8 million 35-39 year old ladies in 1985! This comes about because the 1985 projection is in effect constructed from the 1965 population, minus deaths and minus out-migration; plus in-migration. Those extra 35-39 year old ladies are a net balance of in-migrants, including the wives recruited abroad by military personnel, refugees from Castro, and persons from other immigration sources.

SYSTEMS FOR PERSONNEL ACCESSION AND DISTRIBUTION

The second major category of Army Operational Objectives on our list is Systems for Personnel Accession and Distribution. This category of objectives is concerned with: (1) the identification and measurement of those ability and experience characteristics of the individual which are considered (or can be demonstrated) to predict, limit, or enhance his acquiring of military skills and knowledges and his performance of military duties (his individual characteristics); (2) the design and operation of systems or procedures for the management of inputs and of the career progress and separation of numbers of such individuals (personnel systems characteristics); and (3) the interactive effects of individual characteristics and personnel systems characteristics. Separate operational objectives can be stated for each of these major aspects of personnel system performance, and different research objectives or research requirements can be set for each of these.

a. Individual Characteristics

(1) Personnel Selection

(a) The OPERATIONAL OBJECTIVE here is to develop and validate the most efficient and economical techniques and procedures for use in screening and selecting personnel for military service, including the development and validation of aptitude, personality, and biographical indicators to assist in selecting personnel likely to make the Army a career.

(b) The RESEARCH REQUIREMENT is to extend and augment the technology represented by the Armed Forces Qualifying Test (AFQT) and similar instruments. This involves satisfaction of requirements based on disparate assumptions:

That the selection ratio will be less than 1, as in the past.

That the selection ratio will be equal to 1, which may convert this to a classification, rather than a selection, problem.

(2) Personnel Classification

(a) The OPERATIONAL OBJECTIVE is the same as for Personnel Selection (above).

(b) The RESEARCH

REQUIREMENT is to augment the technology represented by the Army Classification Battery (ACB) and similar instruments, and especially to conceive and establish new and improved individual and group performance criteria against which to validate predictive measures.

b. Personnel System Characteristics

(1) The OPERATIONAL OBJECTIVES are to establish the capability to measure and evaluate the differences between a Data Base of Personnel Assets and a Data Base of Personnel Requirements, and to translate the differences into alternative procurement objectives, training requirements, and command manpower allocations taking into consideration mission performance, unit readiness, and cost or penalty data on "internal procurement" for each alternative.

(2) The RESEARCH REQUIREMENTS are to develop and test rational conceptual models for the accomplishment of the above operational objectives; to construct and test systems of operational procedures to realize the conceptual models and to evaluate these in terms of costs and benefits; and to provide a technology to assist operational elements in such change-over from current procedures as may be demonstrated or otherwise deemed by operational elements to be advisable.

c. Interactive Effects of Individual and System Characteristics

(1) The OPERATIONAL OBJECTIVES are to establish and continuously improve manpower policies that will meet Army force requirements under all conditions of threat and with any given conditions of available resources, including, e.g.: mid- and long-range effects of various RA and non-RA mixes and of alternative time-in-grade-for-promotion policies under various conditions of input and retention; optimum career/non-career MOS mixes; rotational, retention, and severance policies and their differentiation for various categories of military professional competence; etc.

(2) The RESEARCH REQUIREMENTS for these objectives cannot be stated in general terms and will in all cases be specific to a given configuration of system characteristics (i.e. individual characteristics will in all cases be contained in and constrained by system characteristics, but system characteristics are never alone sufficient to specify individual characteristics).

SYSTEMS FOR INDIVIDUAL TRAINING

The third category of objectives is concerned with those training procedures, schools, and systems which the Army employs to teach basic and advanced military skills and knowledge to the individual soldier. It includes Basic Training (BT) and Advanced Individual Training (AIT) in combat support and technical skills, as well as On-the-Job Training (OJT), and it is expedient at present to state the operational objectives and research requirements for these and other categories of training separately as follows:

a. Basic Training

(1) OPERATIONAL OBJECTIVES are: to determine, within acceptable limits of precision, what are the basic skills, know-

ledges, habits, and attitudes which can or must be taught to the individual soldier for his swift and effective orientation to military duties; to devise and apply training methods and devices, programs of instruction, and curricula which are demonstrably superior in accomplishing such training and conditioning; and to integrate these methods, programs, and curricula in rational operating systems for the rapid, orderly, and economical production of the required numbers and qualities of troops under threat conditions of mobilization and build-up, and for later sustained professional commitment of appropriately selected individuals to a military career.

(2) RESEARCH OBJECTIVES are: to identify the skills, specifications of information, and general habits and attitudes that are essential to or supportive of effective performance of military duties; to devise valid and reliable methods of measuring these as they are acquired and retained by the individual soldier in the initial stages of his training; to construct efficient training procedures and programs of instruction which are demonstrably superior in cost and effectiveness in accomplishing such training of large numbers of men; and to combine these into rational progression of curricula whose outputs at initial levels will satisfy immediate force structure requirements for combat and support personnel while permitting regenerative career feed-forward of individuals of selected qualities.

b. Advanced Individual Training and Technical Training

(1) OPERATIONAL OBJECTIVES are: to identify the skill and knowledge requirements for more complex and demanding duties of combat and combat support, including operation and maintenance of advanced technical weapons and equipment systems; and to devise and apply demonstrably superior training methods and devices, programs of instruction, and progressions of curricula and courses in rational operating systems for the rapid, orderly, and economical production of highly skilled troops in sufficient numbers for emergency force structure demands as well as for the sustained demands of a professional, career Army.

(2) RESEARCH OBJECTIVES are: to identify the specific practical and general theoretical knowledges and skills necessary to the successful performance of stated complex and demanding military tasks, jobs, and job combinations; to devise valid and reliable measures of the acquistion and retention of these in training and of their performance in tactical military operations; and to design and construct efficient training procedures and programs of instruction which are demonstrably superior in cost and effectiveness in accomplishing such training of sufficient numbers and qualities of individuals to meet force structure requirements.

c. Language and Area Training

(1) OPERATIONAL OBJECTIVES are: to identify the language skills and foreign area information necessary to the individual soldier for effective military operations in hostile or friendly foreign nations and cultures, including Military Assistance Programs and Advisory Groups, guerilla and antiguerilla or insurrectional and

anti-insurrectional operations, cold war and stability operations, psychological operations and psychological warfare; and to devise and apply appropriate training measures as above for AIT.

(2) RESEARCH OBJECTIVES are to identify the necessary area knowledge and language skills, to devise performance measures, and to design and construct training procedures, etc., as above for AIT.

d. On-the Job Training

(1) OPERATIONAL OBJECTIVE is to identify and measure objectively those skills, knowledges, and habits or traits of character which are most effectively or economically developed by individual experience in real operations, and to integrate such OJT with BT and AIT in rational and orderly systems of military career progressions.

(2) RESEARCH OBJECTIVES are: to devise valid and reliable objective measures of on-the-job performance; to characterize differentially those operations and job situations which maximize such measures for the individual and compare these with measures produced by formal BT, AIT, or other school training; and to arrange orderly effective sequences of such school training and OJT which will optimize operational productivity and individual career development.

UNIT PERFORMANCE MEASUREMENT AND TRAINING

This category of objectives is concerned with the objective measurement of human factors of operational and combat readiness and improved performance of small units, teams and parties; companies; battalions; regiments; divisions; and Armies. It includes consideration of small ad hoc training and working details, combat experimental exercises and maneuvers, and combat readiness field tests; it is expedient here to separate objectives for small-unit training and field exercises as follows:

a. Small-Unit Training and Performance

(1) OPERATIONAL OBJECTIVE is to measure the joint performance of small units or teams of individual soldiers as a basis for assessment and comparison of various alternatives of team composition, equipment, training or other treatment, or tactical doctrine.

(2) RESEARCH OBJECTIVES are: to construct appropriate rational models of small-unit military operations at platoon or lower levels, together with valid and reliable mission-related input and output performance measures; to devise simulated or field experimental unit operations to yield such performance measures for differentiation of alternatives of composition, training, tactical doctrine, etc.; and to conduct such experiments and make appropriate comparisons and assessments of alternatives.

b. Field Exercises and Other Simulations

(1) OPERATIONAL OBJECTIVE is to extend and apply the logic of small-unit performance measures to measurement and evaluation of exercises and maneuvers at company, battalion, and higher levels.

(2) RESEARCH OBJECTIVE is to develop and test extensions of

the Small-Unit Training Research Objective or to develop and test new and larger domains of such models.

TRAINING FOR LEADERSHIP AND COMMAND

It is appropriate to make separate statements of objectives for junior and non-commissioned officer personnel and for senior officer personnel as follows:

a. Combat and Combat Support Officers and Men

(1) OPERATIONAL OBJECTIVE is to assure that each tactical or operating unit of the Army at or below the platoon level is commanded and led by men who are experienced and trained: in the objectives, demands, and tactics of the particular mission situation; in the composite of resources of men and material of the particular unit and its reserves; in the best methods of employing the unit's resources to accomplish its mission; and in coordination of its actions.

(2) RESEARCH OBJECTIVES are: to devise, for evaluation and comparison of unit performance, measures of unit-performance which will be sensitive either differentially or jointly (or both) to differences in unit composition, mission, resources, and employment; and by means of these measures to analyze and identify those characteristics of unit performance and leadership practices which produce the highest measures; to devise training procedures, devices, and programs of instruction for training selected personnel in the development of such characteristics and practices; and to test such training and assist its incorporation in established Army training curricula.

b. Advanced Education and Experience for Officer Career Progression

(1) OPERATIONAL OBJECTIVES are to identify, for each successive level of rank in each arm and service, those knowledges, skills, and personal characteristics which enhance performance of the duties and discharge of the responsibilities of those ranks; and to establish policies and programs of education and career assignment which will assure the optimum acquisition and retention of the stated knowledges, skills, and personal characteristics.

(2) RESEARCH OBJECTIVES are to determine whether in theory or in practice it is possible to devise valid and reliable objective measures for the evaluation, in whole or part, of officer performance; to devise and validate such measures; and to measure the effect on these of various combinations of officer education and experience.

TRAINING TECHNOLOGY AND TRAINING MANAGEMENT

This category of objectives is concerned with the reduction to operational practice and use in Army training of such general principles of training and training management as can be developed and validated by research and applied in Army training by operating personnel. It envisages the development and orderly expansion of a technology of training and its application to the determination of training objectives, job proficiency measures, training program construction and curriculum construction, training program evaluation, integrated total training systems analysis, and computer-assisted training and simulation

technology.

(1) OPERATIONAL OBJECTIVE is to develop and extend a body of knowledge in such form as to be applicable by operating Army training officials in the planning and conduct of effective training courses for military personnel, to include, e.g. a training taxomomy which will enable practical decisions as to training prerequisites and families of related training courses and progressions, training proficiency measures having stateable relations to job performance, training presentation methods and techniques, and other general or special principles of training.

(2) RESEARCH OBJECTIVES are to identify and analyze the specifics of performance required for the effective accomplishment of stated military tasks and operations, and to construct valid and reliable objective measures of such performance; to devise optimally effective methods for training which will demonstrably improve such performance by military personnel; to identify and state general rules which describe the relations among various categories of such performance in, and training for, military jobs and job families; and to organize and present such general rules and principles in a form which will be useful to Army training managers in the planning and conduct of training operations.

PERFORMANCE CAPABILITIES MEASUREMENT AND EVALUATION

This category of objectives is concerned with the development of valid and reliable measures of individual and unit performance and performance capabilities, both (initially) for research use as dependent variables for comparison of effects of various treatments, and (ultimately) for operational use in evaluation of alternatives and options. It includes basic research in support of a technology of performance measurement, applied research and exploratory development of performance criteria in support of personnel management, applied research on effects of environments or battlefield conditions on tactical doctrine and operations, and development of evaluative techniques for assessment of the total performance of complex manned systems, with objectives for these separately stated as follows:

a. Basic Research in Support of a Technology of Performance Measurement

(1) OPERATIONAL OBJECTIVES are to develop and extend a body of knowledge in such form as ultimately to be applicable by Army planners, personnel managers, and combat developments analysts and tacticians, concerning the valid and reliable objective measurement of individual and group performance and performance capabilities; and immediately to apply such knowledge to the analysis and experimental evaluation of Army personnel and training management.

(2) RESEARCH OBJECTIVES are to analyze, define, and characterize those elements and aspects of individual and group performance which can be validly and reliably measured, and to state in specific terms the degree to which such measures can be expected to be sensitive to alternative treatments; and ultimately to identify the situations and conditions of their suitability for field and operational use.

b. Performance Criteria in Support of Personnel Management

(1) OPERATIONAL OBJECTIVE is to provide Army personnel managers with increasingly valid and reliable objective performance criteria and standards for Army personnel selection, assignment, promotion, retention, discharge, and other military career personnel actions.

(2) RESEARCH OBJECTIVES are to develop and extend that area of human performance measurement technology which is concerned with personnel management and training functions, and to present such technology in a form suitable for use by Army personnel and training managers.

b. Effects of Environment or Battlefield Conditions on Tactical Doctrine and Operations

(1) OPERATIONAL OBJECTIVE is to take full account of the effects on human performance of various stated environments and battlefield or other operational conditions in the planning or command conduct of tactical operations and other military activities.

(2) RESEARCH OBJECTIVES are to develop and extend that area of human performance measurement technology which is concerned with effects of various environments, conditions, and treatments; and to present such technology in a form suitable for use by Army combat developments analysts, planners, and operational commanders.

c. Evaluation of Total Performance of Manned Systems

(1) OPERATIONAL OBJECTIVES are to identify and prescribe objective methods for measurement of system performance in terms which are differentially sensitive to the performance of the human components of the total system, and to apply such measures in problems of system selection, assessment of system degradation, and planning for and management of system outputs in tactical operations.

(2) RESEARCH OBJECTIVES are to develop and extend that area of human performance technology which is concerned with the inputs, processing, and outputs of manned systems; and to present such technology in a form suitable for use by Army systems designers, combat developments analysts, personnel and training managers, and operational commanders.

MAN/MACHINE COMPATIBILITY IN DESIGN

As previously indicated, Joint Chiefs of Staff guidance provides objectives in substanially the following terms:

"(i) Application of human factors technology to equipment development.....(for) man-machine compatibility of operation and maintenance............"; and

"(j) Improved means for quantifying behavioral and social science elements of human factors technology to provide base-line data for equipment developers."

Detailed specification of Army operational objectives and research requirements in this category would almost immediately involve separate examination of the purposes and missions of each equipment and system currently under development. We already know that the statements of research requirements appropriate to each of these system objec-

tives would show very extensive communalities. It is unnecessary to the purposes of this paper to explore these communalities at this time.

SUPPORT OF MILITARY OPERATIONS IN DEVELOPING NATIONS

My studies for the preparation of this paper have not as yet presented to me a succinct statement of operational objectives for this category of the same order of discourse as was employed for the previous eight categories. In lieu of precise statements of OPERATIONAL OBJECTIVES and RESEARCH OBJECTIVES, I therefore offer the following reflections on the role of the social sciences in support of military operations in developing nations.

SPECULATIONS ON MID- TO LONG-RANGE PLANNING

Assuming that both overt and subversive belligerence continues between North and South Vietnam, it may be useful to consider the means by which the U.S. military presence and, alternatively, U.S. military force can seek to:

a. Confine the overt belligerence to the Vietnamese theater; and to

b. Restrict and counter any aggressive North Vietnamese and/or Chi-Comm belligerence elsewhere in Southeast Asia (e.g., Thailand, Cambodia, Indonesia).

In considering this matter one must anticipate the likelihood that progressive attrition of North Vietnamese capabilities for overt belligerence may bring an increased North Vietnamese and Chi-Comm reliance on covert and subversive acts of violence. It should be noted that such covert acts are not only less costly than overt deployment of force, but also constitute a return to the more traditional political and economic action-repertoire of the covert and conspiratorially led Marxist "class struggle." Indeed, as recently as 4 October 1967, radio commentators were analyzing the latest turgid pronouncements of General Giap, who appeared to have determined that it was time to recognize that the war will be a long-continued conflict which can return to "Phase II," the protracted, strictly guerilla phase.

Elsewhere among underdeveloped and emergent nations (e.g., Africa, Latin America, the Middle East) one can further speculate that there may in future be fluctuations--both increases and decreases in various times and locations--of the U.S. military presence, but one hopes that there may be no requirements for engagements of U.S. military force comparable to those increasingly engaged through 1967 in Vietnam.

The above reflections, with their pervasive distinction between overt and covert conflict and accomodation appear to demand a clear distinction between the rules of engagement which are appropriate to the deployment of a military presence as contrasted with those rules appropriate to the engagement of a military force.

For further explication of this pervasive distinction, I refer you to the address by the Honorable Robert S. McNamara, U.S. Secretary of Defense, before the American Society of Newspaper Editors in Montreal, Canada on 18 May 1966--almost a year and a half ago. I earnestly recommend the full text of that address to your careful

study. A few selected passages from it will assist to clarify the reasons for, and the nature of, our distinction here between the military functions of presence and of force.

Secretary McNamara identified three broad groups of nations:

First, those that are struggling to develop;

Second, those free nations that have reached a level of strength and prosperity from which they can contribute to the world's peace; and

Third, those nations who might be tempted to make themselves our adversaries.

For each of these groups he then identified distinctive sets of relationships which I think profoundly affect requirements for military presence on the one hand and military force on the other. I quote:

"First, we have to help to protect those developing countries which genuinely need and request our help, and which, as an essential precondition, are willing and able to help themselves.

"Second, we have to encourage and achieve a more effective partnership with those nations who can and should share international peace-keeping responsibilities.

"Third, we must do all we realistically can to reduce the risk of conflict with those who might be tempted to take up arms against us."

Consider the general characteristics of the developing nations:

a. Roughly 100 countries in 1967 are undergoing the transition to becoming modern societies. The rate of their progress is not uniform; they range from primitive, even stone-age, mosaic societies to relatively sophisticated countries well on the road to agricultural sufficiency and industrial competence.

b. Their progress has not generally been peaceful. In 164 out-breaks of violence in the last nine years, 82 different governments have been directly involved, but only 15 of the 164 outbreaks have been military conflicts between two states and not a single one of the 164 conflicts has been a formally declared war. In 1967 there has not been a formal declaration of war--anywhere in the world--since World War II.

c. What is most striking is the direct relation between the incidence of conflict and the economic status of the countries involved:

(1) In the 27 rich nations who possess 75% of the world's wealth and only 25% of the world's population, internal conflict and upheaval is rare.

(2) At the other end of the scale, among the 38 very poor nations with a per capita income under $100/year, there have been an average of two major outbreaks of violence per country during the eight years from 1958 to 1966.

Secretary McNamara was quoted above to indicate that our role (which I remind you often involves only our military presence e.g. on the country team, even when no question of force is involved) is to help provide security to those nations which need and request our help and

are demonstrably willing to help themselves. To quote Secretary McNamara again from the same address:

"The rub comes in this: we do not always grasp the meaning of the word security in this context. In a modernizing society, security means development. Security is not military hardware--though it may include it. Security is not traditional military activity--though it may encompass it.

"Security is development.

"Without development, there can be no security;............ (and security) implies a minimal measure of order and stability.

"The military...can help provide law and order--but only to the degree that a basis for law and order already exists in the developing society.

"The Organization of American States in the Dominican Republic, the more than thirty nations contributing troops or supplies to assist the Government of South Vietnam, indeed even the parallel efforts of the United States and the Soviet Union in the Pakistan-India conflict--these efforts, together with those of the U.N., are the first attempts to substitute multi-national for unilateral policing of violence. They point to the peace-keeping patterns of the future."

I have summarized and quoted at length from Secretary McNamara's Montreal Address of 1966 to clarify the context of guidance which I believe requires us to distinguish between human factors in the exercise of military presence and human factors in the exercise of military force. Meanwhile, of course, if all else fails, the Nation will surely still maintain an alert and improved capability for full mobilization of all of its resources.

If my own reflections developed above, and my interpretations of Secretary McNamara's guidance, can be agreed to be valid, I conclude that the planning for behavioral and social science support of human factors in military operations must give increased attention in the mid- and longer range future to the following considerations:

a. A likely progressive reduction of qualitative selection standards for the training to an acceptable degree of readiness of those military forces required for rapid mobilization in engagements of force.

b. A likely progressive increase of qualitative military professional manpower distribution, assignment, and retention standards for those individuals trained in the measured application of the rules of engagement for military presence.

c. A likely progressive clarification and specification of military doctrine differentiating the rules of engagement of military force and of military presence.

1E. THE ARMY 75 PERSONNEL CONCEPT

James A. Thomas
Office of the Deputy Chief of Staff for Personnel
Department of the Army
Washington, D.C. 22202

BACKGROUND

In years past the large majority of the personnel resources of ODCSPER as the Army personnel policy-maker has been allocated to answering "fire alarms" related to the more immediate time frame or covering a period of FY plus 5, with the result that many changes in the Army Personnel System have been on a Post Facto basis. However, rapid advances in military technology, specifically in the development of weapons systems, in conjunction with sweeping changes in the ecological, political, social and economic environment of the United States have compelled personnel planners to assess the impact of such current and projected changes on the Army Personnel System of future time frames.

In October, 1965, an ad hoc committee formed at the direction of the Vice Chief of Staff and chaired by the Deputy Chief of Staff for Personnel, recommended that a personnel concept be developed for the Army of the future, beginning with the 1971-1975 (referred to hereafter as the 75) time frame. At the time the Chief of Staff approved the recommendation, the Deputy Chief of Staff for Personnel was without the resources to accomplish the task. This condition was remedied recently when the Directorate of Personnel Studies and Research was established. The Personnel Studies Division of this Directorate, an interdisciplinary team covering such disciplines as Economics, Operations Research, Management Science, Military Personnel Management, Psychology, Sociology, and Statistics, was assigned the task of developing the Army 75 Personnel Concept. Much of the effort expended to date has been devoted to the delineation of the areas to be studied, and to devising and testing a methodology which will facilitate not only the development of the 75 Concept but also future personnel concepts.
The Army 75 Personnel Concept studies and subsequent future concept studies of the Army Master Study Program may well be of interest to this conference because they utilize past research products of the human factors and operations research programs. They depend partially on current research projects now in this program. They will continue in the future to produce

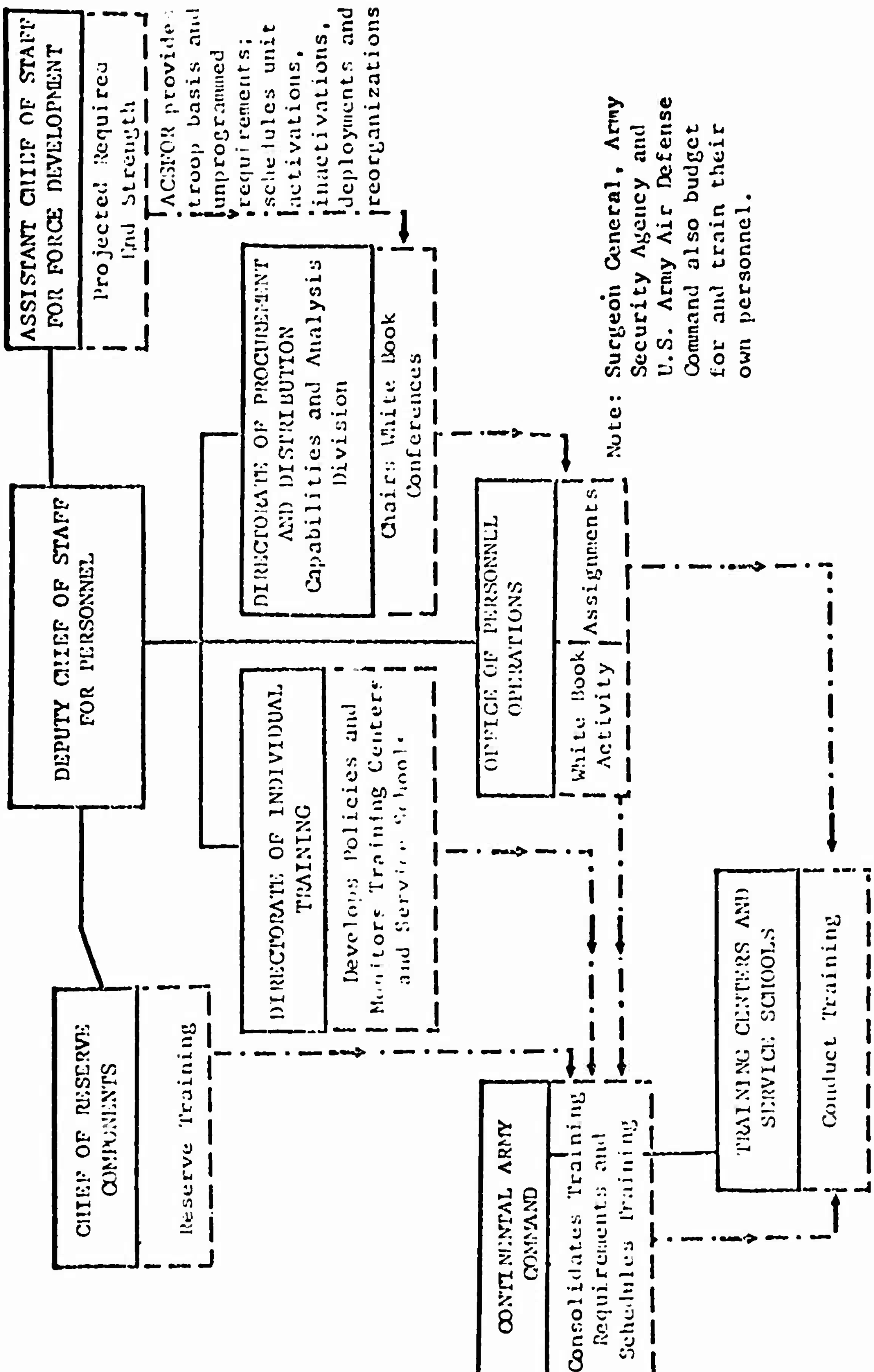


Figure 1. Organization for the Training Function

requirements for research in all aspects in military personnel performance and management.

PROBLEM

The basic problem in this study is the development of a personnel concept for the Army in the 75 time frame. The problem is one of analyzing the current personnel system and based upon the information provided in such forecasting documents as provided in the Army in the Army family of Plans: BASE, ASP, ALRTF, etc., official reports, reports of research, and other pertinent data, to determine what changes in personnel policy are necessary to effectively and efficiently manage Army personnel in the 75 time frame.

SCOPE

The scope of the study will include all military personnel activities designated in Army Regulation 10-5 and Chief of Staff Regulation 10-31 as being under the general staff supervision of DCSPER. For study purposes, these activities have been grouped into five major personnel functions: Procurement, Distribution, Training, Sustainment, and Separation. To the extent that civilian personnel functions interact with these military functions, they will be studied in depth. Each major function will be the subject of a separate study and will comprise a volume in the separate study report, expressed in terms of goals, objectives, and policies.

A sixth volume, which will describe and recommend a unifying Army 75 Personnel Concept, will contain the more pertinent findings and recommendations of the separate studies integrated with those of a more general nature (such as personnel management and general research) into an overall personnel concept. In consonance with the major business of the ODCSPER, that of making personnel policy, the concept will consist of personnel goals, objectives and policies designed to support the Army in the 75 time frame, and will include recommendations for policy development, modifications and implementation as well as recommendations for future personnel study and research.

METHODOLOGY

The methodology to be employed in the study will be primarily judgmental or analytical, with the exception of those instances where quantifiable data will be available for empirical analyses. I will not belabor you with all of the methodological steps; however, I would like to describe several of the key steps which will be generally followed in each of the separate functional studies. Perhaps the best way would be to describe some of the procedures followed during a preliminary analysis of the military personnel training function as related to enlisted personnel.

First, the researcher was required to become well-acquainted with the current training system, that is the organization, the personnel flow, the governing regulations and other policy statements, and any related problems. Organization-wise, the responsibility for the training function is shared at DA by DCSPER, ACSFOR, OPO and CORC. CONARC is charged with the preparation and supervision of training programs to fulfill DA training objectives. An organization chart is shown in Figure 1. In Figure 1, the roles of these organizations are

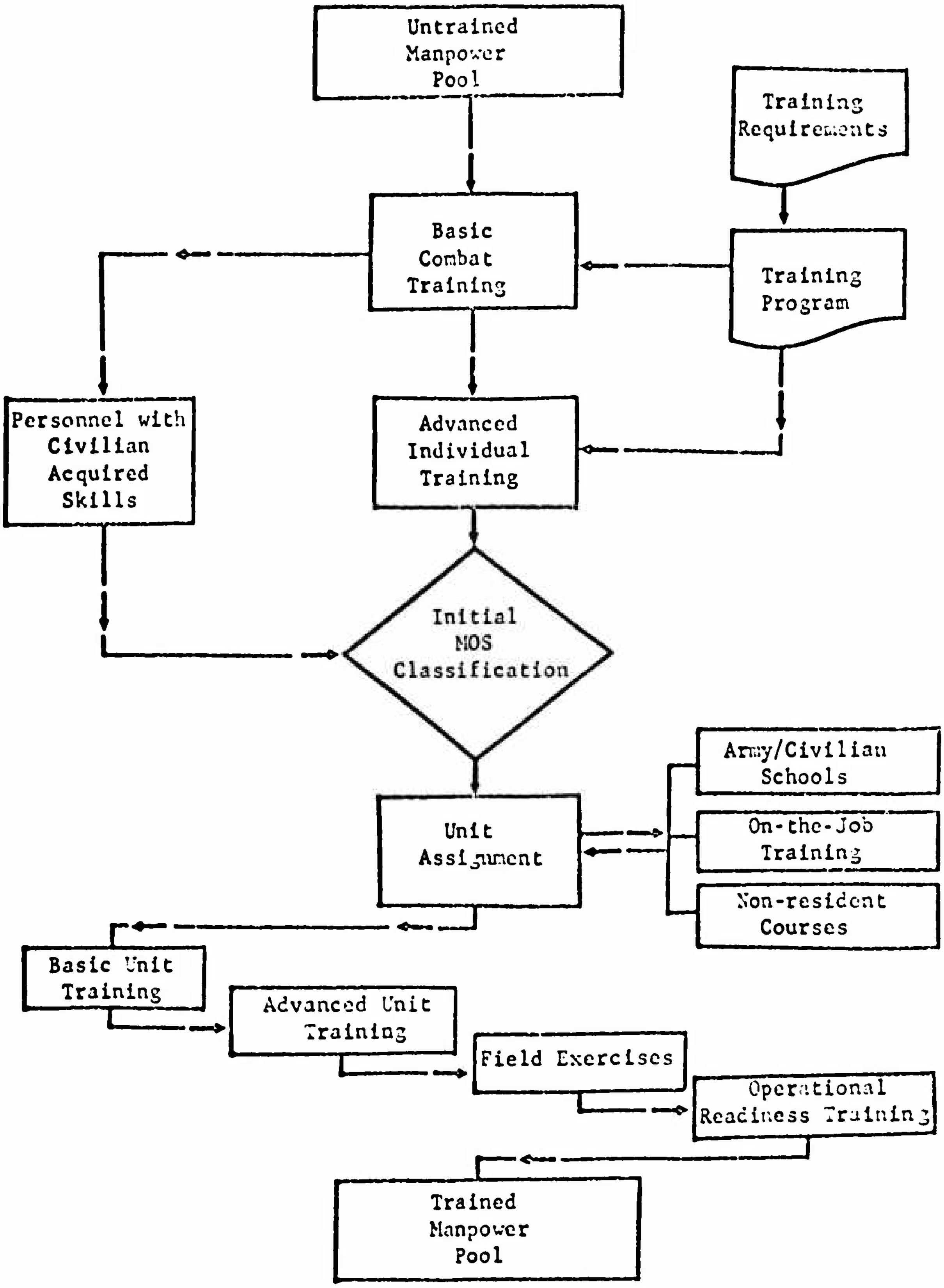


Figure 2. Development of Trained Manpower Pool

apparent with the DCSPER having general staff responsibility for the development of training concepts, policies and programs and the coordination and execution of plans pertaining to individual training in U.S. Army schools and training centers for active Army and Reserve enlisted personnel on active duty.

Current training concepts leading to the development of a trained manpower pool are shown in Figure 2.

The next key step involved the development of training function change requirements, as well as new functional requirements. Based upon a comprehensive evaluation of the impact of the factors outlined in Figure 3 upon the current training system, changes projected as necessary to adapt the current training system to the 75 time frame were determined. These change requirements as well as new requirements were translated into tentative personnel goals and objectives for the 75 time frame.

During this analysis, among the problems discovered was one dealing with On-the-Job training of enlisted personnel. The governing directive for this phase of training is Army Regulation 350-1, with DCSPER being the proponent.

The next step involved a comparison of the tentative objectives covering OJT in the 75 time frame with the directives as stated in AR 350-1. Figure 4 illustrates one of the analytical methods used for this type of comparison. This method uses a matrix to allow systematic examination of tentative future training objectives in terms of current Army policy statements. The objective of this type of analysis is to identify areas in which present policy does not support future objectives and to develop EEA which will be the basis for a more extensive examination from which new policy or further research will be recommended.

From the analysis of AR 350-1, certain policy constraints are evident (Figure 4). The policy constraints are useful in determining areas needing further analysis. After defining the areas for analysis, EEA or Essential Elements of Analysis were developed. An EEA is a question designed to obtain an answer to a particular problem or information that can be used in evaluating a particular functional area. The answers to EEA provide the factual information needed to develop logical conclusions and recommendations. Samples of EEA generated on the basis of the indicated constraints are as follows (Figure 4):

Objective A - AR 350-1, Paragraph 3.a./Type 1 constraint. It is a recognized fact that professional military skill is acquired only through professional military training. The question thus becomes one of what type of skill is most desirable and to what skill level should the mainstream of Army personnel be trained?

EEA

Is the soldier who receives specialized training and who must be periodically retrained more usable than the soldier who gets an adaptable career base via more generalized training?

Objective J - AR 350-1, Paragraph 3.a./Type 2 constraint. To have an Army composed of soldiers with

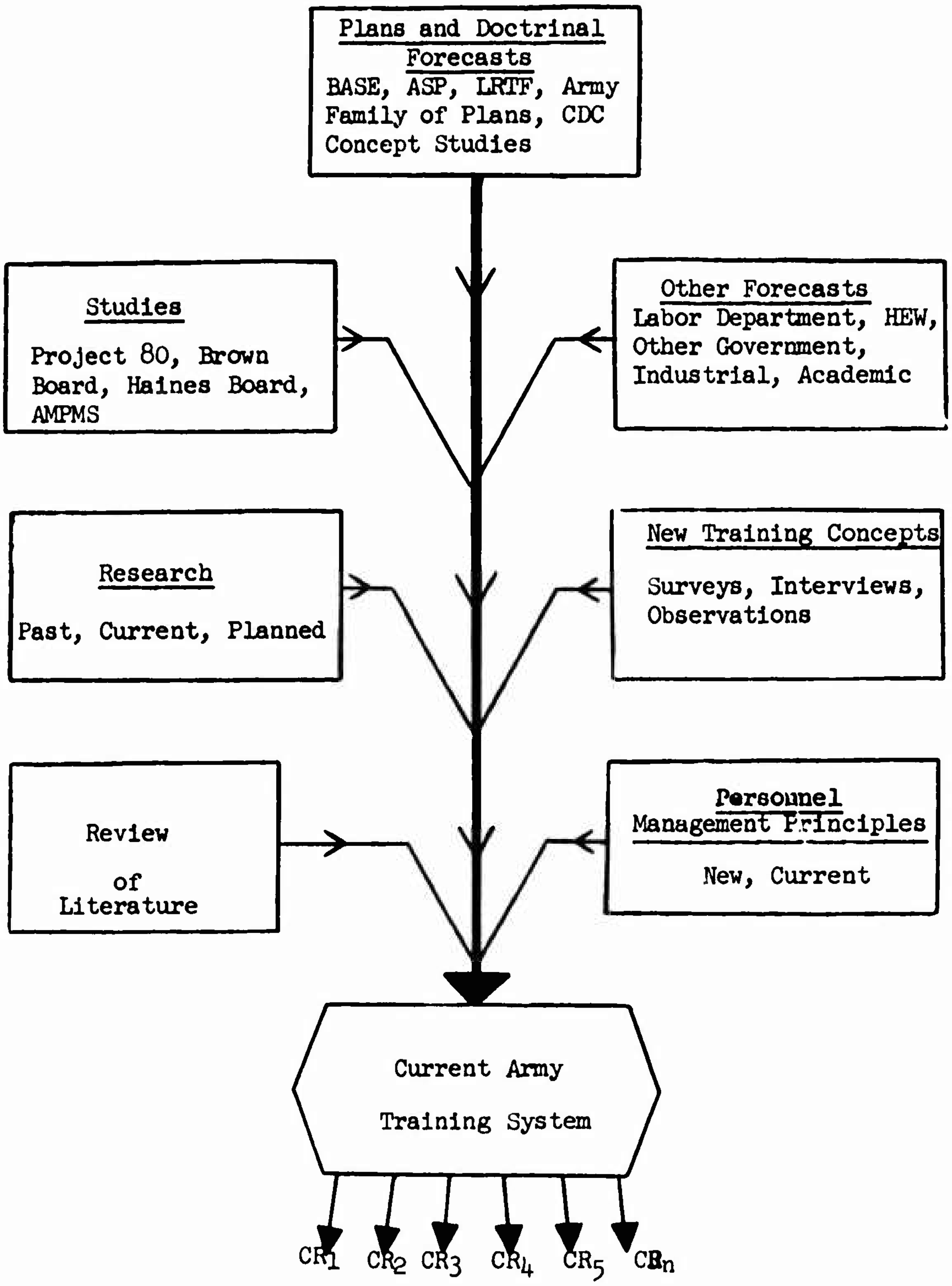


Figure 3. Development of Change Requirements (CR) for the Training Personnel Function

Reference	POLICY	OBJECTIVES									
AR 350-1	Army Training	A	B	C	D	E	F	G	H	I	J
Par. 3.a.	Military skill acquired through training	1	1	NA	NA	Y	1	Y	2	NA	2
Par. 3.b.	Effectiveness product of quality training	Y	1	NA	1	1	NA	Y	Y	NA	Y
Par. 3.c.	Efficient use of training resources	1	3	1	NA	NA	1	NA	1	3	3
Par 3.e. & 3.f.	Goals of training	NA	NA	NA	NA	Y	NA	Y	NA	NA	NA
Par. 3.g.	Management of training resources	1	1	2	2	2	2	NA	Y	1	1
Par. 3.h.	Motivation toward training	1	NA	NA	NA	NA	NA	Y	1	NA	NA

FOOTNOTES: Y = Full policy support of this objective.

1 = Policy lends limited support to this objective.

2 = Development of this objective has implications to make this policy a more viable instrument.

3 = Objective not supported by policy extant, further research is necessary to determine new policy needed to attain objective.

Figure 4. Training Objective/Policy Analytical Matrix

professional military skill a professional military training program at all levels is needed.

Would a DA Training Management Team Concept be feasible and desirable to conduct a training inspection program?

Objective 1 - AR 350-1, Paragraph 3.c./Type 3 constraint. Since training is a major consumer of Army funds, material and man hours, it should be subject to stringent control and evaluated on a cost-effectiveness basis. At present we have no way of costing training because many training costs are hidden in Post funds, MCA funds, PEMA funds and unfunded costs.

Will the determination of learning and teaching cost allow manipulation of length of instruction, size of class, use of resources in a manner so as to approach optimal utility?

The analysis required to provide solutions to these problems will be the next step. This phase incorporates the pick and shovel work, the digging out, arranging and marshalling of facts to answer the questions raised by the EEA. This portion of the Study will be accomplished as individual work but it is expected that researchers will frequently tap the interdisciplinary knowledge pool available to the team; work with Army experts in small teams; place requests for advisory assistance on Army social research contractors; and make opinion and attitude surveys in the field. It is here that the Delphi technique may also be used, where applicable, to assure the development of realistic alternate solutions to problems, and to assist in selecting the best ones.

In terms of our sample exercise, from the final analysis required to provide solutions to the above EEA, the following outputs will be possible:

Recommendations to DCSPER, OPO, CORC, ACSFOR for policy modification, development and/or implementation.

Recommendations for additional military action.

Recommendations for personnel study and personnel research.

Such outputs, assembled and organized across the entire training function, will then comprise the recommendations for the Army 75 Training Personnel Concept.

After each functional concept has been developed, the final action will require cross analysis of the goals, objectives, policies, findings and recommendations of the five functional studies for overlap, inconsistencies, contradictions and interfacings and their integration into the overall concept in conjunction with applicable principles of personnel management (Planning, Organizing, Directing and Controlling).

IMPLICATIONS

The personnel concepts for future time frames are intended as management tools, as basic guidelines to assist the DCSPER to make decisions about the Army's most precious resource in the future. The major benefit of these concepts is that they will provide the DCSPER a broader informational base upon which he can develop various strategies for minimizing the risks or optimizing the gains in planning

for the effective management of the Army in the future. One of the prime sources of such information input is the research completed by the Army's various research activities. Completed research will provide inputs for concept developers (and for other DA staff planners as well) in two ways:

First, consideration of completed research results will point out some of the inadequacies in existing directives, and will lead directly to change requirements, or in some cases, new requirements in concept development or directly to changes in the directives prepared by various DA staff members. In addition, such research may provide a more acceptable range of performance in the parameters involved. Certainly, much of the work accomplished by one of the laboratories in BSRL has been directly responsible for directives governing the many varied aspects of selection and classification of enlisted personnel. I believe that the Follow-Up Study on Category IV personnel also conducted by BSRL in 1961-1962 led to the current project 100,000. The comprehensive research on procurement models by RAC has provided valuable inputs for the DA staff for consideration in determining various procurement policies. The work of HumRRO has been highly instrumental in establishing various training directives. Lesser known to human factors researchers, but immensely valuable to DA staff policy-makers are the many studies by OPO on Military Occupational Skills, computerized and automated assignment and personnel distribution and related topics.

Secondly, completed research results will provide valuable inputs in the analyses conducted for the solutions to the many EEA in personnel concept development. In this step all pertinent facts and data relevant to a given problem are carefully gathered and evaluated in order to obtain the requisite conclusions and recommendations.

In terms of on-going research, the informtion concerning current or planned research will be of value to the concept developer by indicating those potential problem areas which are being covered, and perhaps need less emphasis, and those which are not being covered and perhaps need some emphasis. The programming of current research into future plans will assist in establishing priorities in needed areas. In this regard, DCSPER-DPSR (my organization) has recently let a contract to Franklin Institute on Junior Officer Retention. This project is designed to lead directly to changes in policy affecting junior officers in order to improve their retention rate. In addition, we have let a contract to Battelle Institute on the Army 75 Procurement Concept, since this function is too large and complex to be handled on an in-house basis only with our personnel resources. The OPO sponsored project SIMPO will provide a basis for simulating the personnel functions and to predict and assess the effect of proposed policy changes.

In regard to future research needs, this concept will:

a. Provide a pyramidical building-block structure for personnel research by identifying the needs for generalized core studies and supporting more specialized detail research and studies.

b. Secure the application of

personnel research to military uses by relating research to accepted objectives.

In this regard, and in conclusion, it should be noted that some of our preliminary investigations have determined that the DA staff has urgent problem areas which are completely untouched by our personnel-oriented research resources. These findings also point out a dire need for closer communication between the DA researcher and the DA staff research consumer. It is hoped that this and future concepts may assist in bridging these gaps. The real value of such conceptual studies is at present unknown, but it is felt that their careful exploitation by both the DA researcher and the DA staff will provide another way of helping the Army to get maximum value out of its research dollar.

1F. PROJECT ONE HUNDRED THOUSAND

Charles L. Crain, Colonel, USA
Office of the Deputy Chief of Staff for Personnel
Department of the Army
Washington, D.C. 20310

BACKGROUND

On 23 August 1966, Secretary of Defense McNamara in a speech to the Veterans of Foreign Wars in New York stated: "The poor of America have not had the opportunity to earn their fair share of the Nation's abundance, but they can be given an opportunity to serve in their country's defense, and they can be given an opportunity to return to civilian life with skills and aptitudes which for them and their families will reverse the downward spiral of human decay." He went on to say that there was no desire to convert the military into a Universal Military Training establishment, or to encroach upon other agencies who are charged with "War on Poverty" -- that the Services have an obligation to utilize their capability to improve the Nation's young manpower, so long as in so doing military mission is not impaired or degraded.

Thus, as a result of Mr. McNamara's statement, Project One Hundred Thousand was born and it was determined that a program would be developed to accept men into the Service who previously had been rejected -- 40,000 the first year, or Phase I of the program, and 100,000 each year thereafter.

On 1 October 1966, mental standards for selective service inductees were lowered to accommodate these men. The services were not required to lower enlistment standards, but any man enlisted below the 1 October 1966 established standard of the particular service would be counted as Project One Hundred Thousand.

The Category IV person is one who scores below the 31st and above the 10th percentile of standard population on the Armed Forces Qualification Test. The Project One Hundred Thousand, now called the new mental standard man, is Category IV, but one who scores below the mental standards prior to 1 October 1966. Figure 1 shows the mental standards before and after 1 October 1966 for selective service inductees.

In January 1967 medical standards were changed to accept volunteers with certain medical conditions such as hernia and hemorrhoids which could be corrected by surgery or treatment within six weeks. This is called the Medical Remedial Program.

MENTAL STANDARDS

INDUCTION

AFQT	As of 30 Sep 1966		Current	
	H.S. Grad	Non-H.S. Grad	H.S. Grad	Non-H.S. Grad
31+	Acceptable	Acceptable	Acceptable	Acceptable
16-30	Acceptable	Must pass 2 AQB areas @ 90	Acceptable	Must pass 1 AQB area @ 90
10-15	Must pass 2 AQB areas @ 90 plus GT score of 80		Acceptable	Must pass 2 AQB areas @ 90

Notes: (1) The current standards reflect changes made on 1 Oct and 1 Dec 1966.

(2) The AQB is the Army Qualification Battery. Scores are expressed for seven aptitude areas. The GT (General Technical) is one of these seven aptitude areas. The GT score is based on the verbal and arithmetic portions of the AFQT.

figure 1

MEDICALLY REMEDIAL ENLISTMENTS

Pilonidal cyst or sinus

Hemorrhoids

Undescended testicle, unilateral

Varicocele

Hydrocele

Hernia

Overweight

Underweight

figure 2

PROJECT ONE HUNDRED THOUSAND

Phase I - (Oct 66 - 30 Sep 67)

Service Quotas

New Mental Standards

	ARMY	NAVY	AIR FORCE	MARINE CORPS	TOTAL
Number	30,400	3,400	3,600	2,600	40,000
Percent	76.0%	8.5%	9.0%	6.5%	100.0%

figure 3

PROJECT ONE HUNDRED THOUSAND

Phase II

1 Oct 67 - 30 Sep 68

Services	Medical Remedial	New Mental Standards	
		Total	AFQT 10-15
Army	9,600	60,800	(30,400)
Navy	2,100	8,900	(4,450)
Marine Corps	1,500	7,800	(3,900)
Air Force	1,800	7,500	(3,750)
DOD	15,000	85,000	(42,500)

figure 4

PROJECT ONE HUNDRED THOUSAND

PHASE II

PERCENTAGE CATEGORY IV

(Based on all Accessions)

SERVICE	PHASE I QUOTA	PHASE II QUOTA	DIFFERENCE
Army	25.9%	24.5%	-1.4%
Navy	15.0	17.0	+2.0
Marine Corps	18.0	21.0	+3.0
Air Force	15.0	17.0	+2.0
DOD	22.3	22.2	-0.1

<u>Army</u>

1. Total accessions: approximately 470,000
2. Total Category IV: approximately 115,000

figure 5

TRAINING COURSES REVISED

FIRST CLASS STUDENT MIX

Courses	Project 100,000	Other Group IV's	All Others	Total
FT LEE (7 wks) Supplyman (76A10)	6	4	21	31
ABERDEEN PROVING GD (7 wk) Wheel Vehicle Mech (63B20)	18	5	29	52
FT BELVOIR (10 wk) Engr Equip Maint (62B20)	15	15	33	63
FT GORDON (8 wk) Switchboard Operator (72C20)	9	4	19	32
FT EUSTIS (14 wk) Marine Hull Repair (44K20)	3	4	7	14

figure 6

A list of these medical cond· is at Figure 2. I will not d . . on this program except to say that we are not having much success getting men with these conditions to volunteer, but about 72% of those who do are in mental groups above Category IV.

PHASE I AND II PROJECTS
GOALS - OBJECTIVES

Phase I of the Project started 1 October 1966 and ended 30 September 1967.

During Phase I, and extending into Phase II of the program, the services were assigned three major tasks.

1. First, to accept the Defense Department quota of the New Mental Standards and Medical Remedial men.

2. Second, to examine and revise certain of our training courses and programs to find ways to make learning easier for the lower mental group man.

3. Third, to collect, record, and report a vast amount of information on a name basis on each of the men (79 items to be exact) for research and comparative purposes. Additionally, we are to collect this same information on a small sample of all mental groups to build a wider comparative base.

First, our quota for Phase I. Figure 3 shows the Service quotas for Project 100,000.

OSD goal for Phase II is 85,000 mental standards and 15,000 lower physical standards.

Figure 4 shows that the Army quota is 9,600 medical standards and 60,800 New Mental Standards men for Phase II. Note that at least 50% of these men, for all services, must come from men who score between 10-15 percentile on the Armed Forces Qualification Tests. The AFQT 10-15 range has in the past largely been reserved for the Army. The other men to make 60,800 will come from the mental category AFQT 16-20.

NOTE: Short falls in medical remedial accessions must be made from men who score between AFQT 10 and 30.

Although this number 60,800 for the Army is high and more than we would choose, Phase II will represent a lower percentage of total Category IV accessions. Figure 5 shows a comparison of Phase I and II Category IV accessions. Note a lower percentage from 25.9 to 24.5 for the Army and a higher percentage for the other services. This is a very significant step forward and perhaps sets the future stage for a more equitable distribution of mental groupings among all the services. This 24.5% represents about 115,000 Category IV men.

Currently, there are 240,000 or 17% Category IV men in the Army. By 30 September 1968, Phase II accessions will raise this number to about 290,000 or about 22% of our enlisted strength and about 85,000 or 7% of these men will be Project One Hundred Thousand (or new mental standards.

Now to the second Project One Hundred Thousand task -- that of revising training courses.

Figure 6 shows the revised courses which are now in session and being evaluated. The numbers in the blocks represent the number of students by mental category in the first class of each course. Four experimental classes will be con-

PROJECT ONE HUNDRED THOUSAND

MINIMUM DATA TO BE COLLECTED ON NAME-BY-NAME BASIS

Accession Data

Name
Service number
Service number prefix
Social security number
Date of enlistment/induction
Term of enlistment
Change from inductee to enlistee - date
Date of birth
Birthplace - state
Home of record at enlistment/induction - state
Race: 1-Caucasian 2-Negro 3-Other
Years of education completed
High school graduate/non-high school graduate
Number of school grades failed or repeated
Number of civil court convictions and adverse adjudications other than minor traffic
AQB score each aptitude area (7 items)
AFQT percentile score
Main full-time civilian occupation - DOT, first 3 digits
Number of months main civilian occupation
Typical weekly income over last six months
Total months of all civilian full-time employment
Remedial physical defect (if applicable)
Achievement Tests (4 items)
Zip code - Home of record
Ethnic Group
Age at enlistment/induction

Basic Training Data

Date of entry
Date of completion
Recycled - number of times
Recycled - total number of calendar days
Recycled - reasons (Academic, Physical, Other)
Remedial training unit - number of times
Remedial training unit - total number of calendar days
Remedial training unit - reasons (Academic, Physical, Other)

figure 7

Other Training Data

Type of Entry Level Skill Training
Date of entry
Date of completion
Designation of course
Recycled - number of times, course
Recycled - total number of days, course
Recycled - reasons (Academic, Physical, Other)
Eliminated from course - date
Eliminated from course - reason (Academic, Physical, Other)

Performance Data

Pay grade
Pay grade - date of rank
Reductions in grade
Effective date of reduction
Proficiency pay award - type
Proficiency pay removal
Primary MOS
Current duty MOS
Awards and decorations, code highest three at separation, discharge or reenlistment
Eligibility for reenlistment
Nonjudicial punishment - number
Court-martial conviction - number
Character and efficiency ratings

Retest Data

USAFI Achievement Tests

Educational Achievement Data

Non-high school graduate - (1) Completion of high school, (2) Credits for courses at recognized, non-college, civilian schools, and (3) Credits on USAFI Subject Standardized Tests.

High school and non-high school graduate - (1) Number of courses without academic credits and not resulting in an occupational skill or specialty, (2) Number of certificates resulting in qualification in an occupational skill or specialty, and (3) Number of college or junior college semester hours of credit.

Separation Data

Separation, discharge or loss - complete reason code
Separation, discharge or loss - date
Type of discharge certificate
Home mailing address at time of separation
Reenlistment and date

ducted in all these courses with a similar student mix. Additionally, four controlled classes with about the same student mix using the old program of instruction will be conducted to obtain comparison. Courses were revised to include more training aids, more hands-on and practical training and less lecture, theory, and written material; and more practical, and fewer written tests. The courses were not designed purely for the slow learner -- but to improve the instruction for all mental groups.

Time does not permit me to dwell on the subject of what is being done to make learning easier, and it is too early for a complete evaluation of the performance of the men in these courses except to say that they are performing satisfactorily in the supply and wheel vehicle mechanic course, but many are having difficulty with the more difficult one -- the Engineer Maintenance Course.

Now I will discuss the third and perhaps the most difficult task -- that of collecting information and statistics.

Accepting men in lower mental groups is not unique to the Army. Our mental standards were even lower during World War II and Korea. What is unique is that this project is designed to create a vast bank of detail by name, background and performance data on each individual brought into the service under these "New Standards." It thus becomes a sociological experiment of considerable magnitude and one whose impact can be far reaching. It is certain to attract the interest of educators and particularly human research sociologists and psychologists which you gentlemen represent here today. There is no limit to the possibilities for specialized studies and research that present themselves.

Currently we are collecting 79 items of information on every Project One Hundred Thousand man. Figure 7 shows the type data we are collecting which could be made available to you for future research projects.

(This information is reported to Office of Assistant Secretary of Defense (Manpower) on tape format by all services.)

PERFORMANCE AND TRAINING

We have by no means evaluated all the statistics we have received to date, but from the information we have collected we have reached certain, and I might add, tentative conclusions:

About 40% of the New Mental Standards men are Negroes as opposed to 11% all other accessions.

Many of the men do have a problem reading written training material and manuals, but we have not yet determined the extent to which literacy training may be needed.

From a sample of 1,200 men, 29.7% measured below the 5th grade reading level.

The men do best in "hands-on"skill training. They have difficulty in technical training which requires comprehension of written material.

So far the men have not caused undue disciplinary problems.

The majority can be motivated and the majority want to learn and complete their military training.

Many of these men are making very good soldiers. For example, six men at Fort McClellan recently graduated

from the Leaders Course and became Advanced Individual Training squad leaders. At this point I must say that our qualification tests are good predictors but not exact measurements of ability. Perhaps some of these men are higher mentally than test scores show. Perhaps some have never before had an opportunity to step out and show what they can do.

In the training area we are having considerable success in Basic and Advanced Individual Training, but not without a price in time and manpower. These men do require extra hours of instruction and remedial training , extra supervision and counseling by unit commanders and instructors and consequently a heavier load on the training base.

For example, men at Fort Knox require about 15 hours a week additional instruction; the Ordnance School reports that they give 4-8 hours of night classes each week to men in the Wheel Vehicle Mechanics Course teaching them to use the technical manuals.

Figure 8 shows our current attrition rate in Basic Combat Training.

The attrition rate for the non-high school graduate 3.2 percent for Category IV and 3.5 percent for Project One Hundred Thousand is higher than the high school graduate, but the average attrition rate of 3.0 percent of total input for Project One Hundred Thousand is almost the same as men in higher Category IV and not too much different from higher mental groups. This rate is not as high as we expected and much lower than Air Force Category IV men which is 6.8% and Navy which is 7.2%

Advanced Individual Training: Attrition rate for Project One Hundred Thousand in combat skill advanced individual training is 2% which is about the same for all others.

This is not true in our combat support MOS skill producing courses. Normal attrition in these courses range from 2% for easy skills to 17% for the harder ones or an average of about 8.4%. A survey of seventy-eight hundred (7800) Project One Hundred Thousand men showed an attrition rate which averages 12% (3.6% higher than the average). We have identified several courses where few Project One Hundred Thousand men can pass, for example, Small Arms Repair and Hawk Radar Mechanic.

IMPACT AND CONCERN

In conclusion I would like to touch briefly upon some problem areas and the impact of this program on the basic mission of the Army.

We can probably highlight our concern in four areas.

1. The extent to which the Army can accept substandard men without seriously degrading its operational capability.

2. The administration of the program and its impact in terms of money and people.

3. The impact on our training base.

4. Army's role in relation to other Services in carrying out the objectives of the program.

I will advance a few thoughts on each of these subjects.

First, how many we can <u>accept</u>:

ATTRITION RATE

BASIC COMBAT TRAINING

AFQT		HIGH SCHOOL GRAD	NON-HIGH SCHOOL GRAD	PERCENT
(CAT I, II, III)	31+			1.5
Category IV	16-30*	2.3	3.2	2.9
Project 100,000	10-15	2.6	3.5	3.0

*NOTE: Some Project 100,000 in AFQT 16-30

figure 8

RESEARCH PROJECTS

HUMRRO

Spectrum	-	Training - Marginal
Utility	-	Performance
Support	-	Combat support training

BESRL

Discipline	-	Problem cases
Stockade Population	-	Mental grouping
Aptitudes	-	Small unit performance

figure 9

The Army has played a very positive role in raising the opportunity level for substantial numbers of the population over the past years. Consequently, we have not been reluctant in any way to enter into this important project which can have very meaningful and measureable national benefits. The dilemma of course is at what point must we insist that the Army structure contain enough talent, enough intelligence, enough leadership to accomplish our objective on the battlefield without unnecessary loss of life. The Category IV man has limited potential for advancement past the apprectice or lower NCO level. We know, through past research and experience, that it takes longer to train these men. They are not as alert, they can become proficient in some skills and in others they never reach achievement level of higher aptitudes. The long term dangers to this are a lowered promotion potential, lower quality of NCO leadership and consequently performance problems.

We believe that the data we are collecting and the research now underway and additional required research which will become evident will answer some of these questions on --

How many can we use?

In what skills and MOS? and

What modification in training is needed?

Second: This leads into the second concern, and that is the effort required to develop, maintain, and evaluate meaningful data. In another year we will have close to 100,000 of these individuals on the Army rolls and millions of items of information to assemble and codify. Agencies and commands in the field must collect the hard data which is no small task. If we are not careful -- the information we are now seeking, plus demands for additional information for research potential, may be too big a job to superimpose on our already overloaded system.

Third: Training. Related to this is our training problem. We know that it takes more time and more people to train lower mental groups. More are recycled or reclassified and retrained in less demanding skills. Many now require some literacy training and we predict that this requirement will increase. Instructors must spend more time with the men at the expense of the faster learners. The question is how much additional effort will be required from our overtaxed training base.

Fourth: Finally, I address the responsibility which I believe all services share in bringing the project to fulfillment.

Although the Army has had a great deal of experience training and utilizing Category IV men, we should not infer from this that the Army is the only service capable of effective utilization of this large manpower pool. All services drive trucks, issue supplies, serve food, repair equipment and answer telephones. Therefore all services should accept an equal share of lower mental groups.

We need only to read World War II history when the siphoning off of talent from the ground combat forces created a real crisis in small unit leadership that resulted in countless needless casualties and mediocre performance. It is with these memories that Army leadership approaches with great caution actions which will bring a

lowering of standards of its personnel.

With the experience we are gaining from Project One Hundred Thousand and with good practical research in the right area we should have the answers to our problems.

Our research and experience must tell us how many of each mental grouping we can accept, train, and utilize without wasting our nations limited talent and without degrading our training, our enlisted leadership and skills, and as a consequence the operational capability of the Army.

Current research projects related to Project One Hundred Thousand are listed at Figure 9.

1G. NEW TECHNIQUES IN MOS DEVELOPMENT

Warren P. Davis and Harry I. Hadley
Office of Personnel Operations
Department of the Army
Washington, D.C. 20315

INTRODUCTION

Mr. Chairman, Gentlemen. This morning I'd like to acquaint you with some of the new techniques that are being developed in support of the Personnel Management System of the Army.

First, I'll cover a new technique in job analysis which we call the Military Occupational Specialty (or MOS) Data Bank; next, new developments in job evaluation, and finally, a system for establishing both qualitative and quantitative personnel requirements for new equipment still in the R&D cycle. While these new techniques are directly related to job classification, or MOS Development, as we call it, they will have a major impact on not only other personnel management functions such as procurement, assignment and testing, but also on other areas such as the refinement of occupational training, the development of TOE, and the modification of doctrine.

SYSTEMS OF JOB ANALYSIS

Fundamental to any system of personnel management for a large organization is a system of gathering relevant facts concerning the jobs to be performed, so that the mission of the organization can be accomplished. This process of gathering job facts is called job analysis.

There are a number of systems of job analysis which the Army has employed. These are:

1. Observation Interview.

2. Secondary Reference Material.

3. Structured Questionnaire.

4. Automated Structured Questionnaire.

The oldest, and in many ways still the most valid, we call Observation Interview job analysis, and consists of a trained professional going out on the job site and gathering information on the duties performed and skills and knowledges needed in a manning table position. These job facts are gathered by observation and interview of the man directly on the job. Prior to 1960, we

employed this method with good results. However, it is extremely expensive both in dollars and professional manpower, and is no longer appropriate for mass application to the many, fast-changing jobs in the Army today. Even under our former program with over 100 trained job analysts in the field, we could only average around 200 duty positions a week. As many MOS contain 20 or more duty positions, and there are now approximately 1500 MOS for officers, warrant officers and enlisted personnel, an annual survey of all MOS would create a requirement for over 300 trained job analysts and a staggering travel budget. Nevertheless, Observation-Interview job analysis is still useful for highly technical MOS with long term training where the cost of the job analysis can be offset by potential savings in training expense.

We are currently using the second method--Secondary Reference Material. By this we mean comments of the various schools, Army Materiel Command, Combat Development Command, major commanders and the DA Staff. While this is inexpensive in DA funds and manpower, it may produce a bias in the information gathered, and does not fulfill the Army's need for an aggressive and independent system of gathering job information in a fast changing situation.

We also employ, on occasion, the third method shown--The Structured Questionnaire. This is a set of job oriented questions which are sent out to the man on the job for answering and return. While it lacks some of the validity of the Observation-Interview, it can make up in reliability and consistency by covering a much larger sample of job incumbents. This, however, leads to a problem in processing and analyzing the information from a large number of questionnaires.

The fourth method shown is designed to correct this problem, and is the one we are currently working on.

THE MOS DATA BANK

We call our automated questionnaire system the MOS Data Bank. It was conceived around 1963 when it became apparent that some rapid method was needed to process large numbers of job questionnaires.

We prepared a research project on the Data Bank, and in January, 1966, the Bonesteel Committee approved the project, and put it in the highest priority grouping. It has since been strongly indorsed by the Brown Board.

In July of last year, the Chief of R&D awarded a contract to Operations Research Incorporated for development of the MOS Data Bank, with an operational target date of mid 1968. In view of the potential improvements to be gained thru the MOS Data Bank, however, we are endeavoring to advance this operational date to end 1967.

The objective of the research is to produce an up-to-date inventory of all the jobs being performed by all military personnel in the Army. The project is currently a joint in-house and contract research effort to automate our whole system of job analysis and job evaluation.

The first developmental phase was to survey the User requirements. Major DA agencies

and several commands, including United States Continental Army Command, United States Army Europe, and United States Army Pacific were visited during the survey. We also looked into the related work being performed by the personnel research agencies of the Navy and Air Force at Lackland, San Diego and in Washington.

The primary finding of the first phase was that we need job information in greater volume and more specific detail than we have been gathering in the past.

The second phase is now in process and consists of the development of the structured questionnaires for all MOS to be surveyed. This is being accomplished as a joint effort of the Army Schools and Office of Personnel Operations. About 150 have been completed to date.

The third phase is the design of processing procedures and machine programs to provide input and output from the computer, and the last phase will be the application of the job data to various personnel management programs. The second third phases are being carried on simultaneously.

USES OF THE MOS DATA BANK

When operational, the MOS Data Bank will have wide application to Army programs, and will have direct benefit to almost all Personnel Management programs.

Specific knowledge of the Army's job requirements can lead to refinement and improvements in construction and preparation of occupational training courses and manning table, development of MOS, modification of officer and enlisted standards of grade authorization, better career management, fairer MOS proficiency tests, and many other programs.

A good example of direct use of the MOS Data Bank is in the area of occupational training. Currently, most Service School courses, around 650, train for an MOS. However, the current MOS descriptions are general in nature, and not necessarily engineered in such a manner as to be favorable for training purposes.

If automated print-outs of all the tasks performed in the field by personnel in a certain MOS could be given to the training command, the course designers could include training to cover all such tasks, or that portion of them that the training budget could stand. Contrariwise, items now taught in courses which could not be supported by the field's requirements could be dropped. Also, long courses could be "shredded-out" so that more use could be made of our two-year soldiers and others whose limited capabilities restrict their use.

FUTURE PLANS FOR THE MOS DATA BANK

We are currently carrying out plans for accomplishing a speed-up in the operational date from mid-68 to end-67. The most time consuming phase is the development of questionnaires. We have redirected the contractor's efforts toward the development of processing and machine programming routines so this phase will overlap the questionnaire development.

We are using our own and the resources of the CONARC schools to expedite the development of the MOS questionnaires. Each school

has been asked to develop task lists of MOS under their cognizance in accordance with standardized instructions and terminology furnished by our office.

One of the major problems in questionnaire development is the level of specificity to which the questions should go. Table 1 illustrates the problem. It shows some extracts of duties, tasks, and elements from an occupationally spread sample of jobs.

Table 1
JOB DUTIES - TASKS - ELEMENTS

COMBAT JOB

DUTY - Participates in combat patrols
TASK - Drives M-60 Tank
ELEMENTS - Starts engine
Maneuvers vehicle around and over obstacles

TECHNICAL JOB

DUTY - Takes X-ray pictures
TASK - Performs routine chest X-ray
ELEMENTS - Positions patient Directs patient to hold breath

ADMINISTRATIVE JOB

DUTY - Requisitions and issues unit supplies
TASK - Requisitions Class IV supplies
ELEMENTS - Verifies requisition against catalog number
Types requisition form
Files record copy in "due-in" file

MAINTENANCE JOB

DUTY - Maintains power supply equipment
TASK - Replaces suppression components on gasoline engine portable generator
ELEMENTS - Replaces radio ground brush and spring
Replaces shielded plug
Replaces ignition cable

While no exact figures exist, we estimate that there are between five and seven thousand duties in all enlisted jobs; 100,000 tasks, and possible as many as 10 million elements.

If we go only to what we call the "duty" level, the data might be suitable for MOS work, but not for training or TOE work. If we go down to the "element" level, we run the risk of bogging down the whole effort in excessive and somewhat meaningless detail.

It appears as if the "task" level is best suited to the needs

of all the Users, and we are proceeding to construct questionnaires to that level.

When operational, the MOS Data Bank will give the Army the most up-to-date system of job analysis in existence in any large organization. Duplicate computer tapes and specially designed printouts will be furnished all User agencies. The benefits in improved personnel management and training can be substantial.

JOB EVALUATION

Beside job analysis, we are also working on a new technique of enlisted job evaluation. Job evaluation is the process of establishing a grade for a position in a manning table. Job evaluation produces a set of grade standards which manning table designers and personnel planners use to determine a specific job's grade and to compute the Army basic pay requirements.

We currently use the "benchmark" system of job evaluation in which positions are graded in accordance with their relation to well defined jobs with agreed upon grades. However, a more scientific and more defensible system is clearly required if we are to successfully justify our personnel pay cost to DOD.

Using not only previous Army experience and research in the field, but also the similar extensive experience of the other Military Services and private industry, we have developed a set of ten job evaluation factors which can be used to measure any Army enlisted job.

The second step was to determine the relative importance of each factor to the other job factors. To accomplish this, we first conducted in-house tests of two selected groups--field grade officers and senior NCO's--asking them to give their opinion as to what relative weights should be assigned to each of the ten factors.

Following these tests, we asked the same thing of all Division Commanders and Service School Commandants. With the information received from these sources, we have tentatively developed average weights for each of the factors. The factors and their weights are shown in Table 2.

Table 2
JOB EVALUATION FACTOR WEIGHTS

FACTORS	WEIGHTS
KNOWLEDGE	23
SUPERVISION OF PERSONNEL	15
ADAPTABILITY AND RESOURCEFULNESS	12
RESPONSIBILITY FOR MATERIAL RESOURCES	9
CONCENTRATION AND ATTENTION	8
PHYSICAL SKILLS	6
PHYSICAL EFFORT	5
JOB CONDITIONS	5
FREEDOM OF ACTION	9
COMBAT EXPOSURE	8

In addition to the factors, of course, it is necessary to know the amount of a factor required in a job. Is it average, above average or below average when compared with all other jobs? In order to get at this problem, six levels have been tentatively established for each factor so that the degree of a particular job factor which is required for a specific job can also be determined.

Several months ago a Team visited Fort Campbell to conduct the final test of these job evaluation factors. Fifty selected officers and senior NCO's were asked to evaluate 20 unidentified job descriptions each, for a total of 1,000 evaluations, using the job factors and levels we developed.

Table 3 shows some examples of the material that was given to the evaluators. Although the job title and duty position were not identified, I have added them here for purposes of clarification. All the tasks performed in a duty position are listed. They are grouped by major duties to facilitate understanding. We also show the pertinent knowledges required by the position, and the physical skills needed. Reports indicate a reliability coefficient in the 90's, and most of the variance confined to a ½ grade difference on an average.

Table 3

EXAMPLES OF JOB EVALUATION DATA

MOS: 92B MEDICAL LABORATORY SPECIALIST   DUTY POSITION: HEMATOLOGY TECHNICIAN

DUTIES:

2. Performs Blood Tests

****

Performs differential cell counts
Separate serum from blood
Identify and isolate immature blood cells

KNOWLEDGES:

****

6. Must know metric system for laboratory computations and measurements
9. Must know standard tests such as prothrombin time test, capillary method for coagulation time, and Duke method for determining bleeding time.

SKILLS:

****

2. Finger dexterity
3. Color discrimination

A standardized form was used to get the evaluations. Using the average of the ratings, we can quantitatively evaluate the job by the sum of the numerical values of the factor levels times the factor

weights. This numerical score can then be used to indicate the position in the grade structure at which the job should be "pegged".

The use of the factor comparison system will provide the Army with a new and effective tool which has not previously existed, and will make grade determinations more accurate, more defensible, and more equitable.

NEW EQUIPMENT PERSONNEL REQUIREMENTS SUMMARY

Now let me turn to the last of our three new techniques--the development and scheduling of personnel requirements for new equipment.

One of the most troublesome areas in personnel management has always been MOS for new equipment still in the RDT&E cycle. The problem is one of projecting job requirements for equipment that does not yet exist in a unit.

If new equipment gets to the field without appropriate MOS, the whole personnel system breaks down as soldiers cannot be properly trained, those that have been trained cannot be properly identified, and the assignment system is confronted with not being able to find the right people to send to the unit having the equipment.

Since 1964, we have been using a system we developed to fill this gap. It is an input of information from the R&D contractor, at specified time intervals, while the equipment is still under development. Using zero as the time the first unit is equipped we work back to minus 60 months which is our normal time frame for the average new equipment item. Within this time frame we have established a system of data input at various milestone points. The actual time will vary with the equipment, but the milestones maintain their interrelationship. The system has now been incorporated into the Logistics Life Cycle Materiel Model. The purpose of the model is to assure the timely submission of qualitative and quantitative personnel requirements information (QQPRI) into the personnel planning system.

The Army Materiel Command and their contractors submit information on the equipment at various points in the milestone schedule. This information is translated into job data by OPO, and a tentative MOS position formulated at least 33 months before the equipment is due to be fielded. This tentative MOS decision is staffed with the major commands and DA staff, and a final recommendation is made to DCSPER 15 months before the equipment goes to the unit. This allows time for training to be established, TOE changes, and personnel procurement and selection to be geared up.

In a case in which equipment is changed while in R&D, where doctrine on utilization of the equipment is modified, or when a subsequent model of a fielded item of equipment changes the personnel requirements, the modifications are put back thru the milestones as a recycle action. In the case of Nike Hercules, for example, changed doctrine to use the missile as ground-to-ground fire caused a modification in the MOS. Still later, an Improved Nike Hercules was developed and further changes in the Fire Control MOS were made.

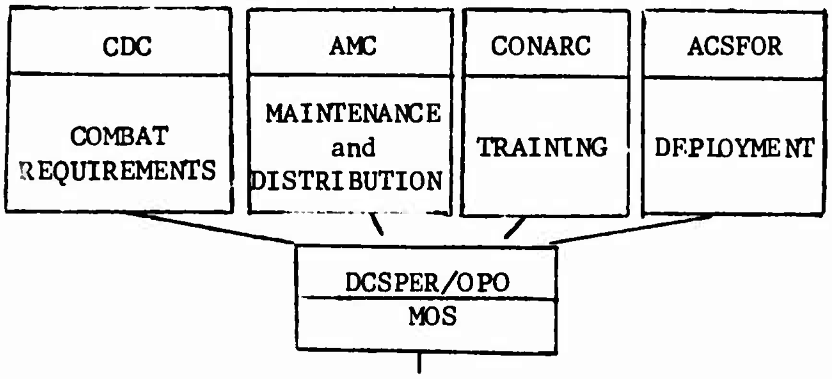
Both actions were done by recycling thru the milestone

system. We also follow phase-out of equipment to delete MOS along with the equipment schedule.

All the pertinent information on each piece of equipment which is new and has personnel implications is gathered together in a semi-annual report called the New Equipment Personnel Requirements Summary. This report gives a brief description of the equipment and states in detail the qualitative or MOS implications, and the quantitative or strength changes which will need to be made when the equipment reaches a point near fielding. The report is used extensively in computing projected personnel and training requirements, and is also extremely useful in manpower and personnel planning.

Table 4

NEW EQUIPMENT MONITORSHIP



MISSILE "A" PERSONNEL REQUIREMENTS

MOS		FY 68				FY 69				FY 70				FY 71				FY 72			
NEW	27C							2		3	3	3	3	5	5	5	5		10	15	20
PRESENT	55F							2		3	3	3	3	3	3	3	3		6	9	12
CURRENT	11B							2		5	5	5				5	5		200	300	400
	11D										8	8	8		10	10	10		150	300	400
TOTAL								6		11	19	19	14	8	18	23	23		366	624	832

Table 4 shows an example of the whole new equipment monitorship system, viewed from the DCSPER/OPO point of view. Information feeds in from the agencies shown on the top, and is translated into specific job terms. In the example of hypothetical MISSILE "A", shown on the bottom part of the Table, one new MOS is needed, one present one needs to be revised, and two current MOS are suitable without modification. Quantities of personnel needed in these MOS are shown by Fiscal quarters. The FY 69 requirements are R&D, those in FY 70 and 71 are for test and evaluation of the missile, and those in FY 72 are operational requirements.

We have been endeavoring, recently, to improve the scope, coverage, content and accuracy

of this system and its resulting report. We are currently expanding the number of pieces that we cover in the report to around 500 items of equipment. We also have secured approval of, and started work on a small research contract to determine how the format of the report could be improved, and how it could be automated. This will speed up the production and usability of the MOS information considerably.

CONCLUSION

In conclusion let me say that this has been a very brief look into the whole, broad area of new techniques for MOS development. There is currently considerable effort being devoted to keeping the MOS Structures up-to-date, so as to truly reflect the personnel requirements that actually exist in the field. The new techniques in MOS Development that I have discussed today will result in substantial improvements when they become fully operational.

1H. MATERIEL LIFE CYCLE MANAGEMENT MODEL

W. C. Lowry, Jr., Lieutenant Colonel, USA
Office of the Assistant Chief of Staff
for Force Development
Department of the Army
Washington, D.C. 20310

My purpose is to present for your information the conceptual model for the disciplined management of the Life Cycle of materiel.

In presenting the Model, I will discuss:

1. Background on preparation of the model.

2. A schematic portrayal of the system depicted by the Model.

3. Features of the Model which represent significant steps in the materiel process.

Preparation of the Model stems from two DA study reports. Each of these reports presented a materiel management model.

The Chief of Staff did not make a decision on either model, but instead, he directed the DA staff, to develop a model for a disciplined materiel life cycle. It was to incorporate those features of each model to best achieve a practical system.

An Ad Hoc group, consisting of representatives from U. S. Army Materiel Command, U. S. Army Combat Developments Command, and the DA staff prepared this Schematic Model and the backup or explanatory sheets for the various steps.

The Model was presented to the Chief of Staff on 6 April at which time he approved the Model as "a basis to guide revision to Army Regulations and for preparation of appropriate DA manuals which will describe the total system in greater detail."

(see Figure 1)

(see Figure 2)

The Management Model adopted includes features that are shown on this slide. I will discuss each of these features when I discuss the Model.

This chart summarizes the Model.

(see Figure 3)

The life cycle is divided into 4 phases as shown. It begins with concepts for the entire Army of the future. These all encompassing concepts are progressively refined to a single materiel system during

A Disciplined Management Model for the Development of The Army

Figure 1

(Note: Copies of the multi-page Model were provided to Conferees. Qualified persons may obtain a copy by writing: Assistant Chief of Staff for Force Development, Washington, D.C. 20310. Attention: FOR DS RT.)

M O D E L   F E A T U R E S

1. COMBINES ELEMENTS OF BROWN BOARD AND COMMITTEE OF FOUR MODELS.

2. SYSTEMATIC ARRANGEMENT TO ACCOMPLISH DOD PREREQUISTIES FOR CONTRACT DEFINITION.

3. APPLIES SYSTEMS APPROACH.

4. PROVIDES PERIODIC DISCIPLINED CHALLENGES.

5. SHOWS USER-DEVELOPER-TRAINER-HIGHER HEADQUARTERS INTERFACES.

Figure 2

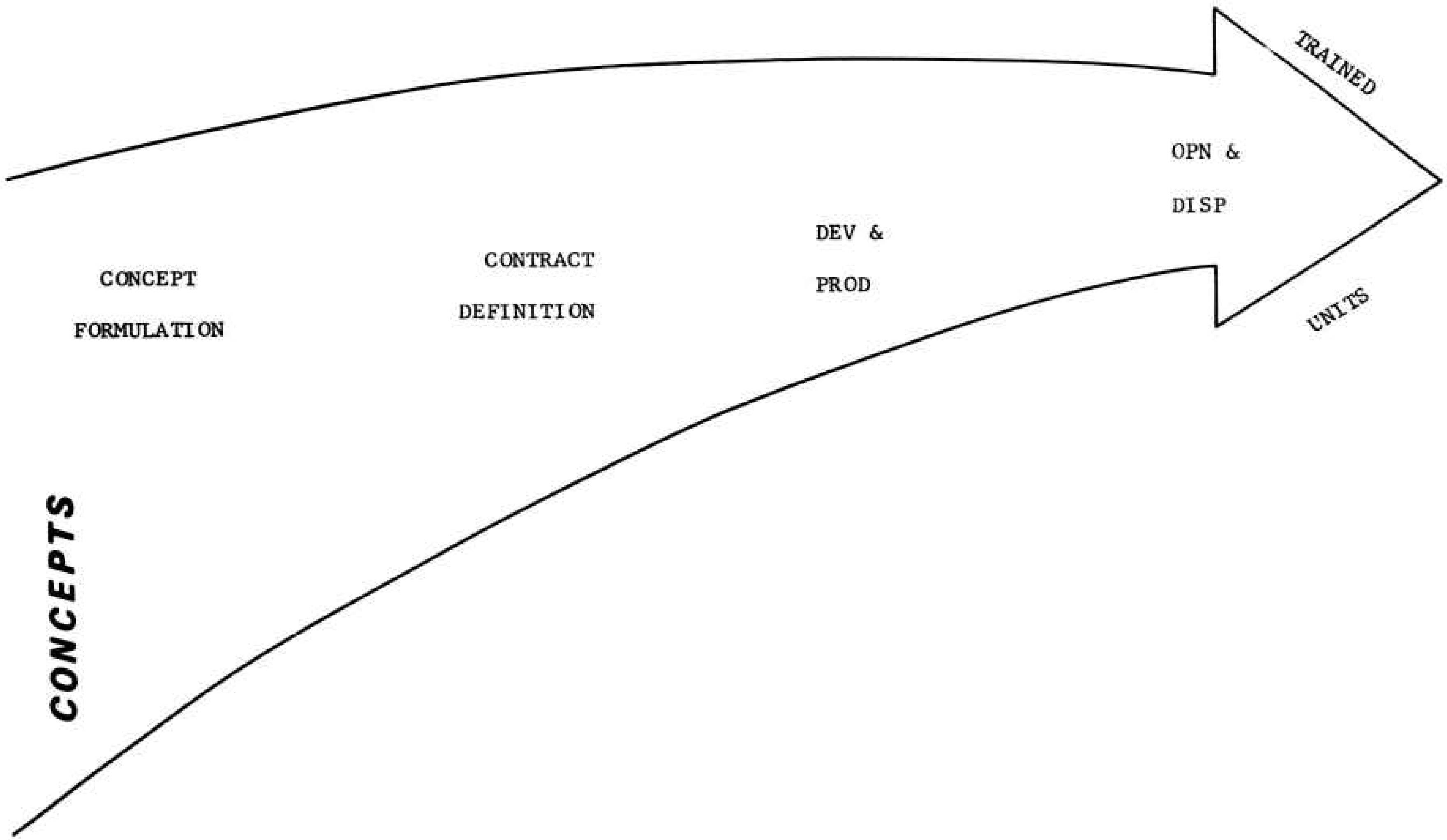


Figure 3 (Part 1)

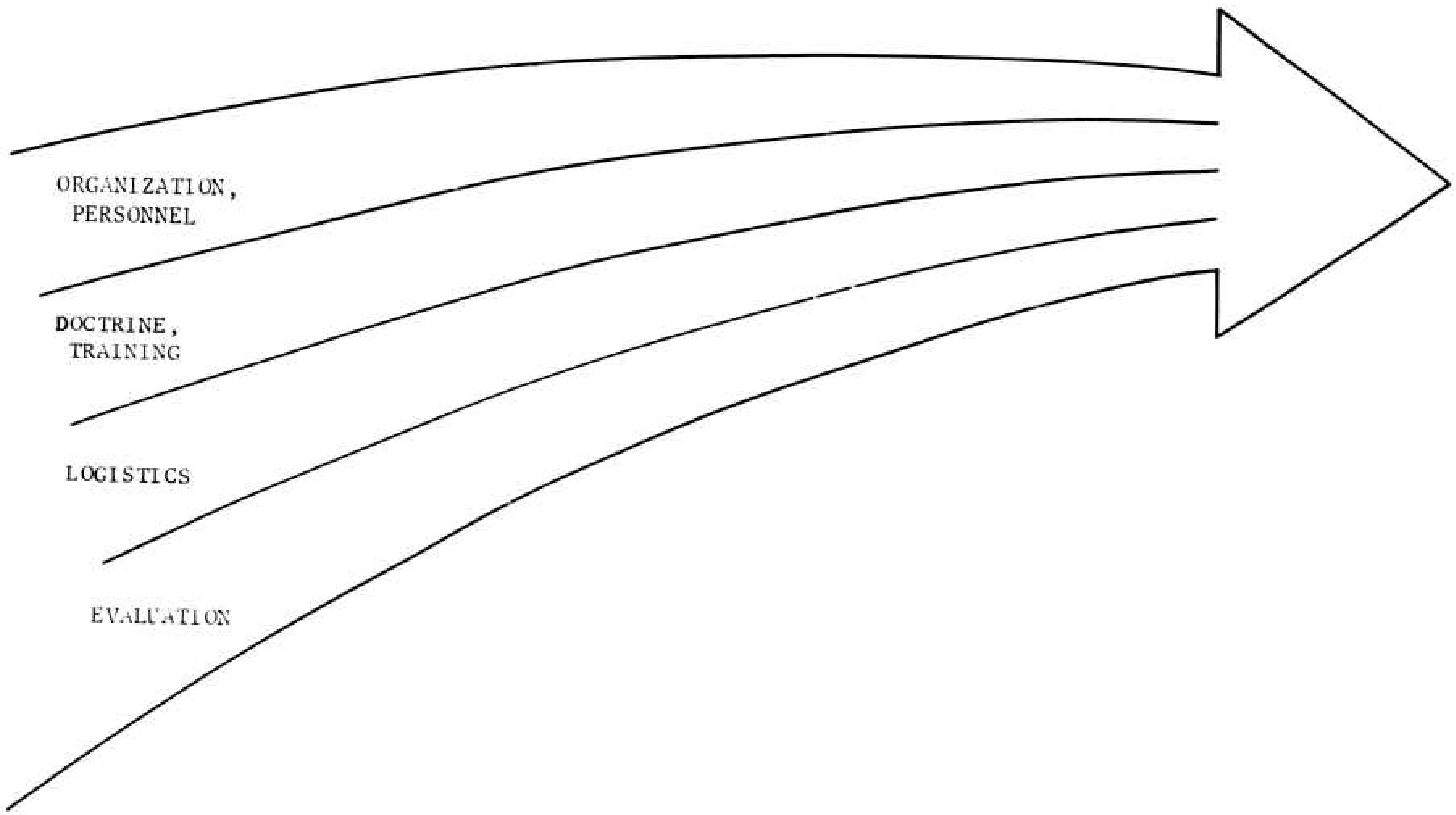


Figure 3 (Part 2)

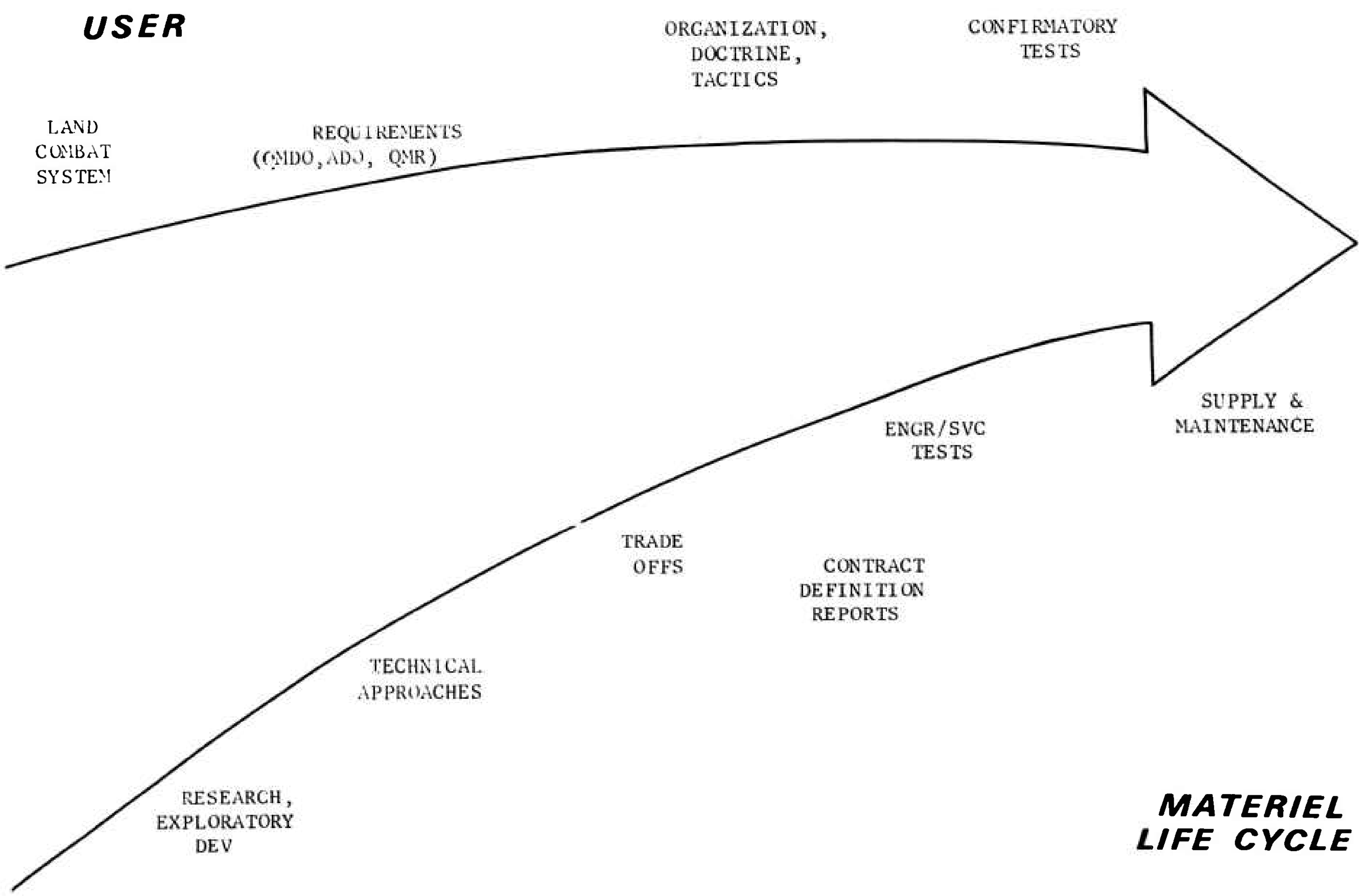


Figure 3 (Part 3)

the latter portion of the concept formulation phase. The Model then traces this single system through contract definition, development and production, and operational and disposal phases.

The transition between each phase is not discrete since lead times involved made it necessary that certain actions overlap.

The Model is systems oriented - it is not for development of material hardware only.

(see Figure 1)

Throughout each phase, specific steps are reflected to insure that related organization, personnel, logistics and evaluation actions are accomplished concurrently with the materiel they support.

The format of the Model is designed to show the interfaces between the user, the developer, the trainer and higher headquarters.

(see Figure 2)

For example, the Model has the user (Combat Developments Command) analyzing and projecting the world environment to design the land combat system needed at a future date. The user needs guide the research and exploratory development by the developer.

The results of the developmental effort, fed back to the user, will enable him to refine his broad design and doctrinal studies to state requirements more precisely. The Model provides for continuning inter-action between the user and developer on technical approaches and trade-offs as the broad objectives become directed to a specific materiel system. The Model then depicts the process for getting that system, developed, produced, distributed, operated, and finally phased from inventory.

Generally, the Model makes some modification to the current materiel acquisition system, but does not involve revolutionary changes.

I will not cover the 239 steps block-by-block, but will highlight significant features and key areas.

Certain blocks are color coded on the big chart. Green indicates a significant decision or challenge point. Red indicates those points where ACSFOR has DA responsibility.

The logic used for the schematic portrayal is shown on left edge. Starting at the top, is the combat developer, (USA Combat Developments Command (CDC)), higher headquarters, the materiel developer (USA Materiel Command, USA Security Agency, The Surgeon General or the Chief of Engineers) and trainer (US Continental Army Command) here. The lower line of the materiel developer is the Project Manager. These sections are further divided into output, activity, decision, policy, and action. I wish to point out the Model is not time related.

The process starts here at Block 1 where the long range intelligence forecast, joint and Army plans, national and DoD policies, and the long range technological forecast are used by CDC for studies of future land force organization and operations. The CDC internal efforts will provide a report (Block 5) entitled "Army Tasks and Threat Forecast." This is a new report which will project the world environment, possible conflict situations, and Army tasks to cope with the environment,

about 20 years in the future. This report, after review by HQ DA, will provide guidance for preparation of alternative conceptual designs of the land combat system (Block 8). This land combat system study, which will have a target year such as 1990, will be much more comprehensive than the current CDC concept series such as Army 70 and Army 85, which it will replace. Operational capability objectives or OCO's at (Block 10) will be derived from this study.

The CDC study and OCO's, when approved by DA, will provide guidance in research and exploratory development as well as direction and guidance to doctrinal studies to support the future Lnad Combat System.

Another significant feature is at Block 23 where CDC begins to direct operational objectives toward specific systems. Here CDC specifies mission and performance envelopes for a system, and the developer responds at Block 24 with possible technical approaches. Subsequently, the action proceeds to steps of trade-off determinatin (Block 32), trade-off evaluations (Block 33), force structure guidance (Blocks 36 and 37) and cost effectiveness studies (Blocks 38 and 39). These procedures will insure that responsibilities for the six DoD prerequisites for contract definition are delineated and completed systematically by the time the justification for the system is submitted to DoD for approval. At Block 40 where the Qualitative Materiel Requirement (QMR) is prepared, the Model becomes oriented toward development of a single system.

When the QMR is approved, a working task group is formed at Block 43 which consists of representatives of AMC, CDC, CONARC, and others as appropriate. This task group will operate under a charter issued by the Army Chief of Staff and will prepare the entire system development plan (Block 47) including the technical development; training, personnel; supply, maintenance and other logistical and funding considerations. The total package of the system development plan, QMR, and Program Change Request will be considered by the major commands at the concept phase System Status Evaluation (SSE) (Block 52). These SSE's are another new feature. These are CDC-AMC-CONARC level conferences with general officer attendance to consider and evaluate all pertinent information available on the system. This includes not only technical feasibility, risks, and problem areas, but the original threat and any changes to it, and support considerations. The formal SSE's provide the disciplined challenges to determine subsequent actions for development, including whether development should continue at all. A go, no-go decision. Recommendations of the SSE are forwarded to DA - Assistant Chief of Staff for Force Development (ACSFOR) for approval, and if appropriate, addressed by the Materiel Requirements Review Committee.

If the decision is to proceed to contract definition, the request is submitted to DoD (Block 56). If approved, the project manager is then chartered by the Secretary of the Army (Block 57) and the procedures for contract definition follow beginning at Blocks 60 and 61.

A key decision for the contract definition phase is shown at Block 92 where the source selection authority considers all information and selects the primary contractor

for the system.

With approval to proceed, the establishment of the engineering development program element, (Block 94), the contract definition phase ends.

The development and production phase may be characterized as a series of activities concerned primarily with the development, testing, and evaluation of prototype equipment; and the production, testing and validation of initial production items to insure that the mass produced system meets required performance criteria. You will notice on the Model that most of the activity now takes place under the direc ion of the project manager or Commodity Commands if the system is not project managed.

One of the first activities shown on the chart is preparation of a request for real estate, Block 98, to include facilities required for testing and evaluation as well as those required for development and production, and for deployment. Land acquisition, particularly for a system like a large air defense system, must be initiated several years in advance of actual deployment.

The development contract for full scale development is awarded at Block 105, another key step in the cycle.

At Block 106 the project manager, assisted by the trainer, combat developer and contractor prepares a master plan and schedule for development which specifies time phasing, development milestones, cost estimates, logistical support plans and personnel plans. It defines the management concept and technical approach. The consolidated plan, at Block 110, becomes the basis for informing participating organizations and agencies of their responsibilities.

Following preliminary design and engineer effort shown at Block 111, the total maintenance requirements are developed at Block 112, as a joint effort among the developing agency, CDC and CONARC.

The preparation of total maintenance requirements integrates personnel, training, organization, logistic doctrine and production requiements into a comprehensive maintenance and support plan. Based upon this plan, and the updated Qualitative and Quantative Personnel Requirements - QQPRI -, Block 117, DA (Office, Personnel Operations) makes a tentative Military Occupational Speciality - MOS decision, shown at Block 119.

At Block 122 CONARC and the developing agency prepare advanced individual training plans and programs for DA approval at Block 126.

The series of Blocks beginning at 133 pertain to testing and evaluation and production of prototype equipment. Block 133 shows the preparation of detailed plans for engineer design tests, R&D acceptance test, physical teardown, engineer and service tests. These plans up-date those initially outlined in the Systems Development Plan made during the concept phase. Plans include inputs from CONARC and CDC. This input includes a new requirement for CDC approval of the service test plan, Block 135.

The results of engineer design test, the prototype equipment, and minutes of in-process reviews are analyzed by the major commands at the prototype system status evaluation at Block 144. This is the first evaluation where the

commanders can examine hardware, though it is prototype.

If DA approves continuation of the development, shown at Block 146, the developing agency, with contractor assistance, conducts new equipment training for personnel involved in testing and support of the prototype system shown at Block 147.

Blocks 159-162 show major inputs from the developing agency and CDC. The draft Army Materiel Plan, (AMP), Equipment Distribution Plans, (EDP) plan Tables of Organization and Equipment (TOE) and tentative Basis of Issue are staffed in DA as shown in Block 162.

Major commands conduct the Development Acceptance system status evaluation at Block 167. Results of engineering and service tests are available at this time. DA - ACSFOR may type classify the system as Standard A, conditional, at Block 170, which would constitute approval to continue the program. Standard A conditional is a new feature and was adopted since the true capability of the mass produced item is not known until completion of production validation. Thus final type classification - as Standard A is delayed.

After the materiel developer at Block 179 has conducted production acceptance tests, first edition technical manuals and field manuals are published and distributed and final revisions are made to the Basis of Issue as noted in Blocks 183 and 185, and DA has approved the recommendation of the Production Validation system status evaluation at Block 193, the decision is then made on type classification at Block 195.

Following type classification Standard A, DCSLOG assumes general staff responsibility for the system from the CRD at Block 196 and support is transferred from the Project Manager to the commodity command at Block 197.

At Block 201, CDC completes Plan Tables of Organization and Equipment and Basis of Issue. TOE are published, and the training base establishes resident training, as shown in Block 205.

At Block 206, full scale production is initiated for the programmed buy. The first unit is equipped and unit training begins at Block 211 which marks the end of the development and production phase.

Confirmatory tests, Block 214, and special evaluation of current operations become the basis for revisions to field manuals, Tables of Organization and Equipment and materiel shown in Blocks 215 and 219. Changes to materiel may be minor product improvements having little impact on doctrine, training or organizations. Major changes to a system may require recycling through the model to include additional research and development effort.

Block 222 shows stock distribution studies, which cover older items in the inventory and project new items shortly to enter. Overhaul, retrofit, and follow-on procurement may be programmed to fill requirements as noted at 223.

Based upon the materiel status of units, planned organizations and reorganizations, and new equipment to be introduced, DA updates the Army Force Development Plan, contingency plans, and logistic plans as shown at Block 224 and 225.

Production shown at Block 235, to

include modifications and product improvement, continues until the Authorized Acquisition Objective is reached at Block 236. CONARC phases down resident training at Block 237 as the requirements are reduced and on-the-job training becomes adequate as a change-over to new materiel approaches.

At Block 238, obsolete items with no further use to the Army are so classified and reported to DCSLOG for disposition. Block 239 shows disposal action which is initiated after screening has been accomplished throughout the Federal Government.

With completion of disposal action the disciplined life cycle of materiel is completed.

In conclusion, I would like to point out that the Model, like my discussion, does not describe all of the steps involved in this complex process. All systems will not necessarily have to follow this stylized approach from concept to disposal. For example, breakthrough in technology may permit the omission of certain exploratory and advanced development efforts. The principles of the Model are mandatory for those projects which meet threshold criteria for contract definition and will be applied selectively to non-project managed items.

The Model does provide for an orderly systems approach with key control, evaluation and decision points for the entire materiel life cycle.

Before finally concluding, I will briefly review the status of the Model.

1. First - The Model itself - the Assistant Chief of Staff for Force Development is the DA staff agency charged with the life cycle management and evaluation of materiel.

2. (Current status as of October will be given. This will include a statement of the status of the Army Regulation revision and progress in re-aligning development milestones to the Model.)

11. COMBAT DEVELOPMENTS COMMAND REQUIREMENTS

Seymour Goldberg
U. S. Army Combat Developments Command
Fort Belvoir, Virginia 22060

The purpose of my presentation is to briefly cover the establishment by the Combat Developments Command of requirements for studies in behavioral Sciences. CDC represents the user in the development of the Army. This mission makes human factors a major concern of our Headquarters. In performing its mission CDC establishes many requirements for studies within the areas being addressed at this conference. In fact, it probably gives rise to as many of the studies as any other single agency in the Army. This occurs both indirectly and directly.

A large portion of the requirements which USACDC establishes come about by indirection, at least so far as the agency which performs the research is concerned. These studies include the larger part of the CDC requirements. Therefore, the great interest of USACDC in this field is probably not as well known as the volume of requirements generated would merit. Requirements are also generated directly through specific requests for specific studies by USACDC or its agencies. The direct studies although numerous, can be expanded to advantage. A notable increase will result as the action officers in our agencies become more conversant with the capabilities of human factors research. The Command is making a real educational effort in this area, as is evidenced by the fact that over 20 of our members are attending the conference. One action which would be of assistance in "selling" behavioral science research is the use of terminology more familiar to potential users. Another factor which has limited the use of direct study requests is the time required for completion of a research project from initiation. There is not much which can be done about this by the research agency, although any acceleration would help. One way that we can help in CDC is by identifying desirable research areas in a study sufficiently in advance so that they can be incorporated as input. Here again we are making an effort to have these matters brought to the attention of all personnel.

So much for the general requirements of the Command for assistance in human factors research. I would now like to get a little more specific by first showing you this

HOW

MAJOR "PRODUCTS"

STUDIES

- SHOULD THE ARMY FIGHT

DOCTRINE--FIELD MANUALS (FM's)

- SHOULD THE ARMY BE EQUIPPED

MATERIEL REQUIREMENTS

- SHOULD THE ARMY BE ORGANIZED

TABLES OF ORGANIZATION AND EQUIPMENT (TOE)

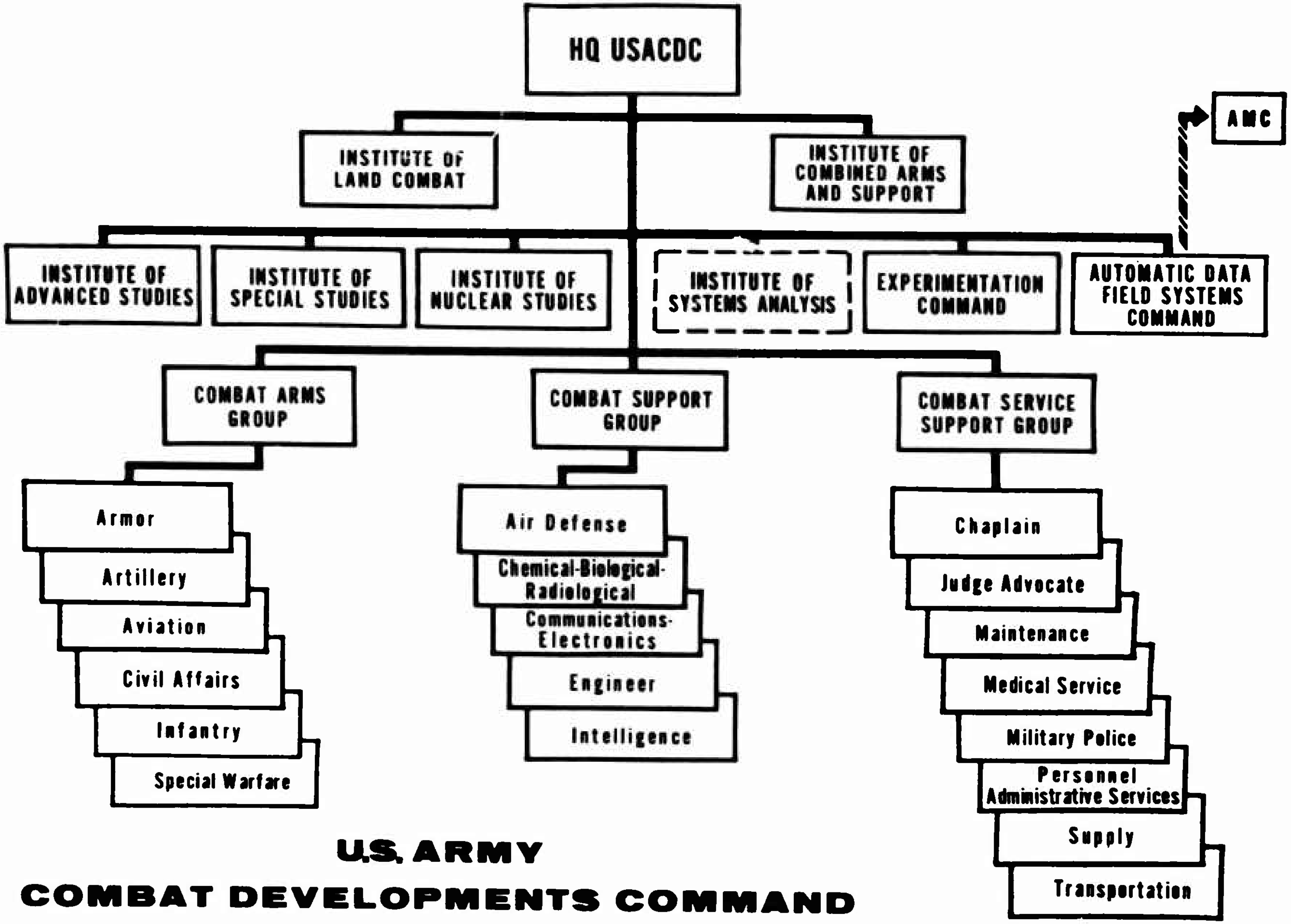
Figure 1

slide which is a statement of the mission of CDC. (See Figure 1). How should the Army fight? How should the Army be equipped? How should the Army be organized, from the present on for a period of 20 years in the future? Each of these missions give rise directly or indirectly to human factors research requirements.

First, how should the Army fight? This is normally determined in the early part of the CDC program in our doctrinal and derivative studies. In these studies questions arise as to the ability of human beings to perform new tactical concepts. One big problem is the span of control; that is how many units or people can one individual control in a given situation. This problem is presented by all Army units from squad up. Studies and analyses of this important subject, particularly at the lower levels, are constantly arising. The changing nature of warfare makes many changes in this area, although it is interesting to note the consistency with which the squad has stayed in fairly narrow limits of about 7 to 12 men throughout the history of the Army. Other areas in determining how we fight which have given rise to many requirements in human factors research are the ability of personnel to gather information leading to intelligence, the times that the individual can remain in combat without suffering degrading effects and the ability of individuals to discharge the increasing complexities of modern warfare. Tied in with these studies on how the Army should fight is the problem of training, since an Army which is not well trained can not do a job on the battlefield regardless of the excellence of its theory. Much human factors work is done on training. While the bulk is the responsibility of the U.S. Continental Army Command, CDC must consider training implications in the studies it prepares.

Turning from how the Army should fight to how the Army should be equipped it is the responsibility of CDC, normally based on the concepts of how the Army should fight, to state materiel requirements. While there are several documents which do this the principle one is the Qualitative Materiel Requirement (QMR). The QMR when approved by the Chief of Staff, Department of the Army is the official statement of a requirement for a particular item of equipment. Since this is a document which expresses the needs of the user, it is essential that it include human factors considerations; in fact, paragraph 10 of the QMR is devoted to a statement on human factors requirements. I am sorry to say that paragraph 10 itself often makes rather general statements, although there has been considerable improvement recently. However, within other paragraphs of the QMR many statements of human factors interest are included. For instance, for equipment which will operate in low temperatures a frequent stated characteristic is that controls can be operated by men wearing gloves. It is the requirement in the QMR which furnish the basis and the inspiration for the further, more detailed human factors engineering prepared by the Army Materiel Command during its development of the actual hardware.

Turning now to how shall the Army be organized, the CDC based on its concept of how the Army will fight and how the Army will be equipped, develops the organization of the Army which is expressed in terms of Tables of Organization and Equipment (TOE's). Here again human factors research may be required although it often comes out



U.S. ARMY
COMBAT DEVELOPMENTS COMMAND

Figure 2

COMBAT DEVELOPMENTS COMMAND

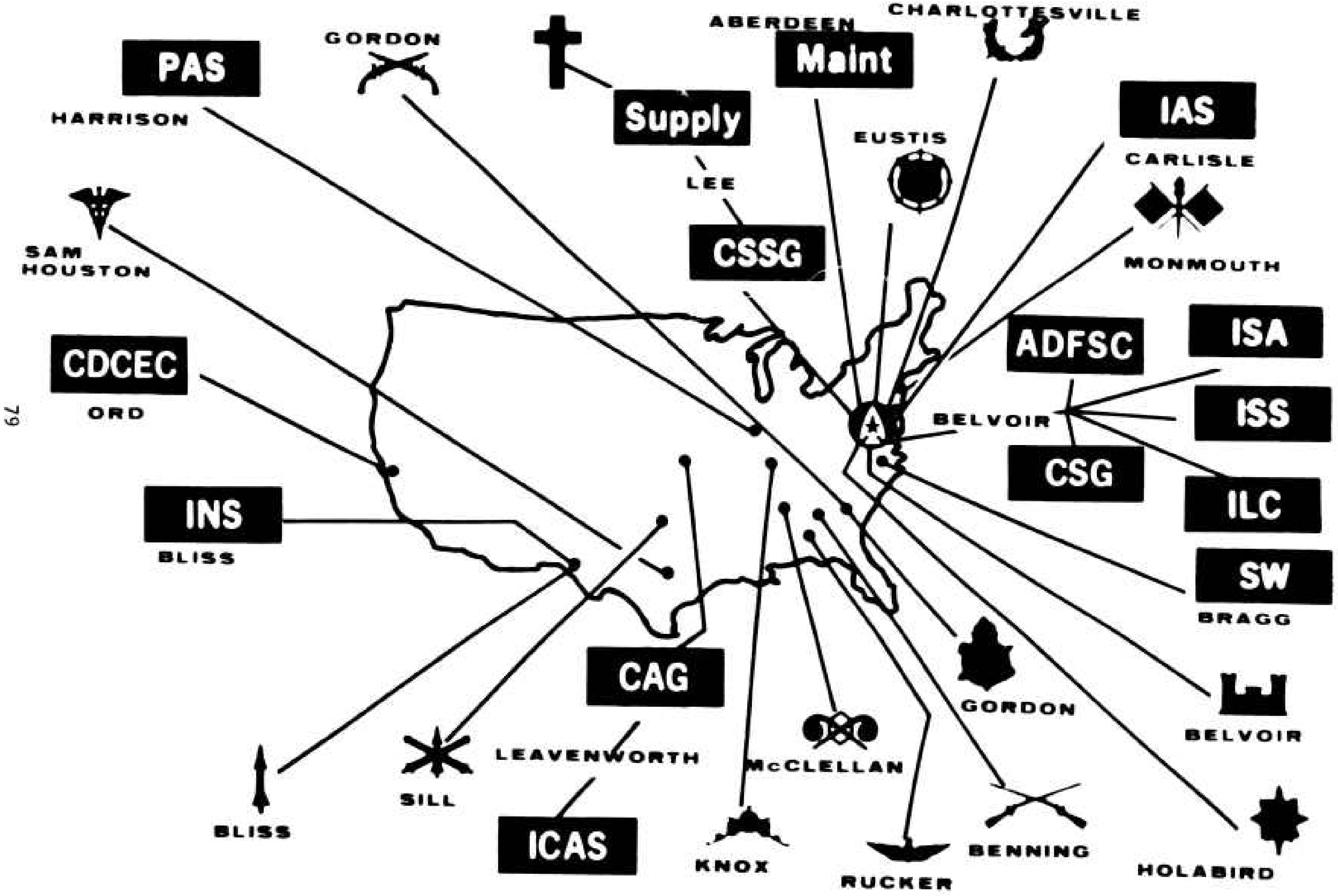


Figure 3

indirectly. As an example, consider the number of cooks in a TOE. The number of cooks in an organization is directly related to the amount of food a man must consume, the environment in which he must consume it and his willingness to eat prepackaged rations rather than hot individually prepared meals. The pressures to reduce support personnel on the one hand and the importance of morale on the other have caused a constant fluctuation in assignment in the number of cooks over the years. This is an area which has been examined by human factors research in the past, and I expect will be looked at from time to time depending on which one of the pressures are uppermost. Another area which has received considerable attention is the amount of equipment which a man can be expected to carry as an individual load without degrading his ability to fight. As a result of studies in this area a good deal of emphasis has lately been placed on making equipment lighter and reducing in number the items which a man is required to carry. Hopefully, the standard of about 50 pounds which prevailed at the time of the Civil War (and which the infantry man of the recent past will tell you has not gone down) will be reduced as a result of the study effort.

Having discussed the manner in which USACDC elements generate requirements for human factors research, I would like to illustrate how these requirements--the ones directly addressed to research agencies--are translated into work requirements. To give the best picture, I should first like to show briefly the USACDC organization. (See Figure 2).

The units directly subordinate to the Headquarters are the Institutes, generally engaged in large unit studies, the two Commands, which are field agencies, and the groups and their subordinate agencies which deal in low level detailed operations and generate by far the largest number of direct human factors requirements. I should like to note in passing that since they also prepare QMR's, they also generate most of the indirect requirements.

This slide (See Figure 3) shows the wide geographical distribution, - not a random distribution, but a collocation with Army Schools, - and of importance to us here, with HumRRO Agencies.

Initial discussions by our agencies which may lead to a human research project are most likely to be informal. There is a constant exchange of informal information at the action level between agencies and human factors research organizations, such as HumRRO and BESRL, and other human factors research organizations which can furnish this service. Much of what one might call the "low level" human factors information gets into USACDC actions in this way.

When it becomes evident that detailed research will be necessary, the agencies make requests through their groups, for the particular support. This is in the form of a letter with standard information. Where BESRL is concerned or the research will be performed by an agency having a sustaining contract with the Army the work can be initiated literally in a matter of days (if the priority is high enough). Where an outside contractor is required, then the usual contracting procedures are followed. If the request is approved but does not have the high enough priority, it will normally be put into the research program for the next fiscal

HUMAN FACTORS RESEARCH REQUIREMENTS

1. Improve Information Displays
2. Cope with Degraded Surveillance Conditions
3. Study Night Surveillance from Aircraft
4. Examine Reactions of Long Range Patrols
5. Analyze 2-Shift Staff Operations
6. Improve Speed of Photo Interpreters
7. Improve Identification of Details in Terrain
8. Provide Better Relation of Terrain to Information
9. Analyze Demands on Observers
10. Determine Minimum Levels of Required Information
11. Improve Location Accuracy

Figure 4

year.

In addition to the specific requests initiated by our Agencies, we require all USACDC elements to prepare a yearly program for human factors research to be included in each request for annual funds. This information is generally gathered through a "dragnet letter". Last year, in addition to the many actions for human factors research developed individually, the dragnet letter resulted in approximately 20 projects, in several of which we participated as sponsors with other agencies. So you can see that there is a constant requirement for human factors research being set up by USACDC, informally, through formal annual programs and through formal individual requests.

As the final portion of my presentation in order to furnish a concrete example and to tie in with the presentations to follow I would like to highlight a USACDC study which has produced extensive requirements for human factors research. This study was called Tactical Reconnaissance and Surveillance (TARS-75). It was directed by the Chief of Staff, Army, to update our intelligence structure by determing the Commander's needs for intelligence at each echelon, examining the capability of the many types of new equipment to gather this information and insuring that the information could be processed and converted into intelligence in time to meet the Commander's need for it. Recommendations to fill in gaps are included in the study. This study took well over a year and had much effort, to include private contractual effort expended upon it. While a good deal of attention was placed on the equipment in the study it of necessity uncovered many areas in which human performance was the key. In these areas proper selection of individuals and development of proper training programs will make as much of a contribution as the expenditure of large amounts of money on complex hardware. Some of these areas are in Figure 4.

When the Chief of Staff rendered his decision on the TARS study he made 14 major decisions; one of which was: "That BESRL and HumRRO be tasked to provide the required human factors data essential to the analysis of operational reconnaissance and surveillance systems, and that support of these agencies will be included in all phases of the testing of the TARS-75, operational and organizational, concept, pretest, test and evaluation."

I have attempted in this short discussion, to indicate the importance of human factors research to the USACDC, and the way in which actions are generated to satisfy these requirements. It can be anticipated that the level of effort by USACDC will expand as the personnel of the Command become increasingly aware of the contribution which human factors research can make to the quality of their studies.

1J. RESEARCH IN SUPPORT OF PSYCHOLOGICAL OPERATIONS

Louis A. Waple, Colonel, USA
U.S. Army Special Warfare School
Fort Bragg, North Carolina 28307

In General Leminitzer's words, ". . . The Cold War is fought on a variety of fronts: Political, economic, sociological, psychological, and military. Yet at root it is psychological."

In his 26 January 1965 letter to senior Army commanders, the Secretary of the Army stated, "Commanders must habitually integrate psychological operations with operational planning." He pointed out that "Lessons learned in Vietnam and other areas of unrest have emphasized the importance of PSYOP and have served to confirm the fact that it is a necessary and indispensable military activity."

General Westmoreland in his Directive 525-3 of 14 October 1966 directed commanders at every echelon to consider both the military and psychological objectives of each operation.

Much has been said in recent years and months about psychological operations, and, of what has been said, much has been less than complimentary. Those of us in the business take small umbrage from the criticism, for, it is less of an assault on a man's ego when he is being criticized than when he is being ignored. Taking liberties with Sir Winston Churchill, we do not resent criticism, even when for the sake of emphasis it parts, for the time, with reality. The important thing is that psychological operations is no longer ignored. And too, having commanders manifest concern about the state of psychological operations has long been an intermediate goal of the psychological operator. When the decision maker or the commander began to demand effective psychological operations, we realized that we had finally reached the point where the qualities we possess - or lack - had received command attention -- a significant milestone in the historical development of any military endeavor.

I intend to discuss Human Factors Research requirements in suggested answers to three questions. What has happened to focus command attention on PSYOP? What is our current capability to satisfy the demand for effective PSYOP? And what must be done to make our capability satisfy the demand?

PSYOP is not new, either to the armies of history nor to the United States military establishment. Successful leaders have always used

it - albeit most often done by charismatic personalties or their inspired and viscerally attuned lieutenants who recognized opportunities by some indefinable quality that they seldom understood and rarely could explain to others. In the past the situations of conflict were normally more clearly defined. The enemy was most frequently, identifiable. The slower reaction times that were allowed permitted a high degree of centralization of political/psychological tactics.

Today, in the insurgency environment, the individual soldier must make certain political judgments and psychological assessments. When under fire, he frequently is called upon to make extraordinary judgments before he returns the fire. Staffs and commanders are no longer judged so exclusively in terms of the efficiency with which they employ men and materiel resources. Today such employments are evaluated in terms of their political and psychological effects - and, not only in the immediate operational area but over the full range serviced by satellite communication. Within 24 hours of the moment a serviceman ignited a thatched roof on a VC house suspected of containing weapons in I Corps, the incident made the front page of the Frankfurther Zietung and for months afterward the accusations and recriminations reverberated around the world and up and down the length of Vietnam. You can well imagine the great concern caused by the use of defoliants, rice contaminants, and other chemical weapons of the non-toxic variety, and the enormous effort -- often after the fact -- to persuade the ill informed of the justification for such tactics. There are new and intense facets to modern conflict. We anticipate it will be so for the foreseeable future, be it stability operations, or Revolutionary Development, or Internal Defense and Development or Rural Reconstruction as it is known by its various labels. Such conflict demands knowledge and awareness not generally found in the "normal" soldier or officer. Basic to problems of stability operations is knowledge beyond the enemy, the terrain, and the weather and such knowledge in my opinion is not yet produced in sufficient quantity by the Army intelligence system.

Human factors knowledge, a basic prerequisite for effective psychological operations, is in rapidly increasing demand, and it is in this area that we find ourselves critically dependent upon the professional community represented here this morning. With it, we can, in a short time, elevate ourselves from mechanics to operators. With it, we will be equipped to insert meaningful data into the decision making process and assist the commander in the development of concepts of operations that take into account the political and psychological potentialities in any given operational situation. And, with it we can develop and produce propaganda that will have the specificity that we believe to be a prerequisite to effectiveness. With it we can cope with the severe limitations on professionally trained and technically proficient manpower that now and for yet a long time in the future will limit the effectiveness of PSYOP units. And <u>this</u>, more than any other reason, is the basic cause for the criticism of PSYOP.

I should like to depart from my announced approach to this problem briefly to refresh you on several psychological operations principles which must be understood fully to appreciate the answers to the other two questions I am about

PROPAGANDA CYCLE SHOWING PLACEMENT OF PSYOP TEAMS THEREIN

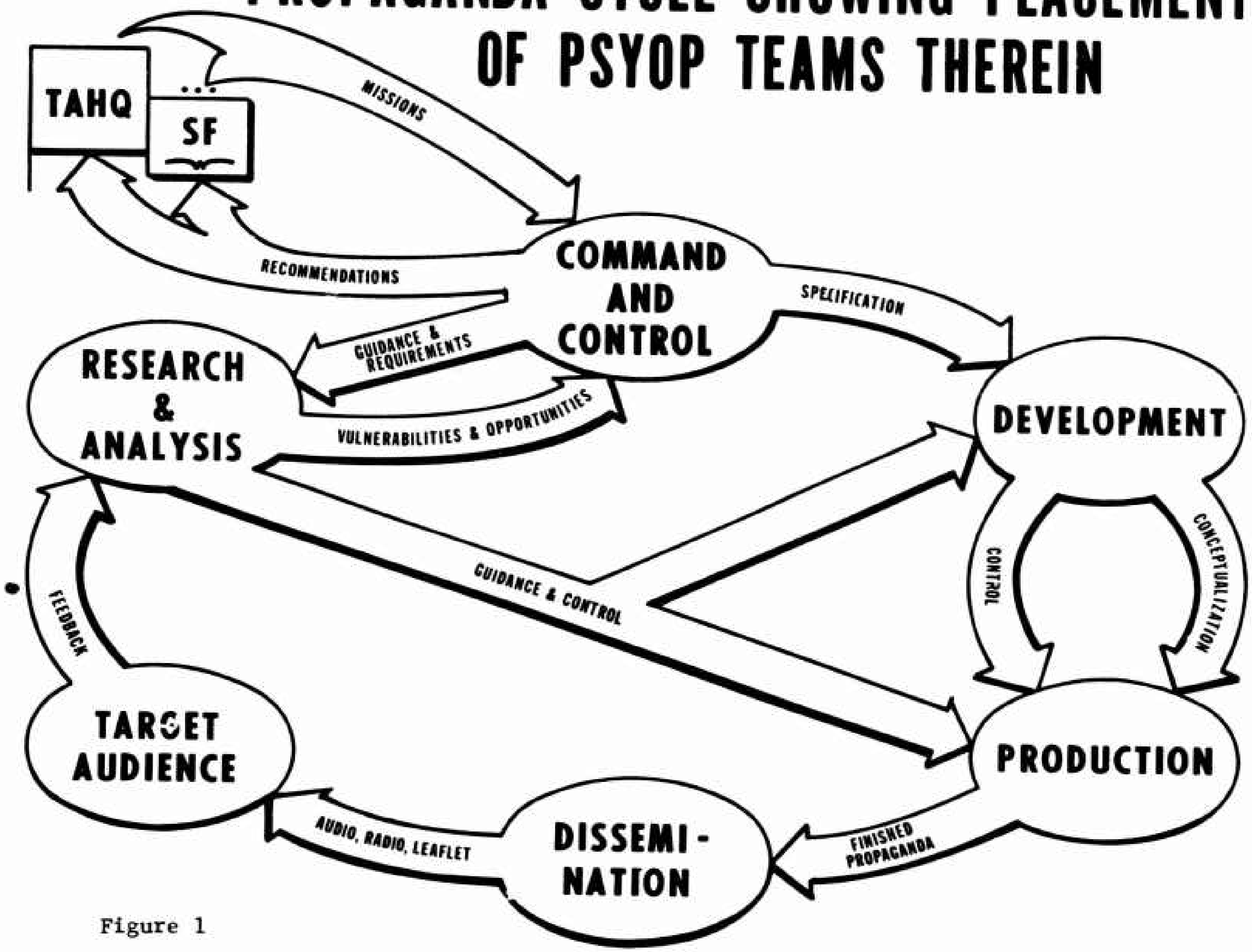


Figure 1

to address. You will recall that they would deal with our current capability and what must be done about it.

This is a diagram of the propaganda cycle. (See Figure 1). Everything that goes on in a PSYOP unit is found within this cycle. If any part of this cycle is left out, or fails to meet its designed capabilities, the cycle is incomplete, and the effectiveness of the psychological operations unit will be inadequate. Broadly speaking, the involved activity falls into two categories: Firstly, advice and assistance, or recommendations, to the supported commander and his staff. Secondly, preparations for and the conduct of the propaganda campaign in support of the operation. What I have said before about your part in PSYOP applies to a critical degree in both categories. I shall quickly explain this cycle in terms of those two categories of activity.

Let's consider the second category of activity first. Clustered about this diagram in their functional relationship are the type teams that make-up a PSYOP unit. Central to the unit is the Command and Control Element which directs the operation, prepares the propaganda campaign, and supervises the other elements. It is from the command and control element that the commander or his liaison officer goes to offer the advice and assistance to the supported unit.

To the immediate left is the Research and Analysis Element, which on the basis of Human Factors Research and Analysis, produces the estimate of the psychological situation and identifies psychological vulnerabilities and opportunities in the target area. To the upper right of center is the Development Element which in response to the specifications of the commander and the quality control from the Research and Analysis staff develops the propaganda. Here appropriate music is selected from a record library, selected excerpts from foreign or domestic radio broadcasts are recorded, news commentaries and specialty items are prepared. Here also writers and artists prepare drafts of graphic materials also under tight quality control. Here the content for loudspeaker tapes is assembled.

Below the Development Element is the Production Element where complete radio or television programs are put together, ready for broadcasting or telecasting. There the finished and approved graphic material is, by the photolithographic process, printed in leaflet, poster, handbill, newspaper, or pamphlet form. There loudspeaker tapes or scripts are finalized. All propaganda completed -- ready for dissemination by the next element below. And there by means organic to the PSYOP unit or means provided by the supported command, the propaganda is disseminated in printed, radio or audio visual form.

While of course not a part of the unit, the next element in the cycle is the target audience. And from the target we obtain, by a variety of means, the feedback which gives us a measure of our effectiveness. This feedback is analyzed by the Research and Analyses Element and modifications to our campaign result, better tactics are devised, and new vulnerabilities are identified. The process never ends until a new mission is received. It continues to be self refining and adaptive to changing situations.

Now let's consider the first category of activity -- the advice and assistance, or recommendations,

to the commander and his staff. This diagram shows, in the upper left quadrant, two arrows -- one reads "Recommendations or Advice and Assistance" leading to the two representative type units shown there - a Special Forces "A" Detachment (the smallest Special Forces unit) and a Theater Army Headquarters (that headquarters which commands and controls all Army elements in a theater of war) - the inner and outer limits of a PSYOP Group's advisory and assistance responsibility. You can properly insert all sizes or types of military organizations in between those two including such highly specialized organizations as a Civil Affairs Command, a Military Police Command, or a Joint Unconventional Warfare Task Force. The other arrow reads "Missions" and missions could stem from any of the organizations I've mentioned. Whatever the support requirement, the size or mission of the supported force, a very important set of circumstances exists which deserves your attention. And, out of the relationship with supported units come the most persistent criticisms and the most damaging ones since they come from the commanders. This is understandable for the very reason pointed our earlier that the commander's performance is being evaluated on the basis of political and psychological fall-out from his operations. With careers at stake, commanders are most understandably intolerant of inexpert advice, assistance, or recommendations. Consider that what the PSYOP unit commander or liaison officer offers as input to the decision making process at this time is based on ten or eleven weeks of PSYOP training at Fort Bragg with, hopefully, some months of on-the-job training. Then consider that what the commander receives from his own staff and subordinate commanders is based on protracted and repeated branch assignments and schooling in the entire spectrum of warfare - albeit still heavily biased on the side of conventional warfare and only now including appropriate familiarization with PSYOP.

Our man, in this relationship, must be equipped with sound, scientifically developed, human factors data that describe the attitudinal patterns and behaviors of the involved populations. Ideally, he would like to know the sum total of the attitudes and behaviors of all the population groups in relation to all of the political, military, economic, and social issues and to the environmental conditions within the area of operations. Being so equipped he would be better able to forecast the probable impact of military operations on the involved populations. He could know what patterns of behavior would facilitate attainment of the military objectives, which ones would negate or lessen the probability of success, and, by all of that, he would be better able to identify psychological opportunities and requirements for our propaganda campaign. Practically speaking, he can function with much less. The mass media we employ permit, -- and I am tempted to say, "with some legitimacy" -- permit some shot gun tactics. But even bird shot misses the bird unless the hunter has pointed the shot gun with reasonable accuracy. The designers of PSYOP organizations intended that the Research and Analysis Element of the unit be organized to produce PSYOP intelligence, prepare estimates of the psychological situation which identify population groups in the target area and forecast their behavioral responses to national and local issues and the operation itself. The Research and Analysis Element is designed to assess their susceptability to propaganda, assess

their effectiveness in influencing a change in behavior of members of their own and other groups. The PSYOP organization is designed to do many things to provide the PSYOP liaison officer and PSYOP commander with human factors data on which to base recommendations, advice, and assistance to the supported command. However, in reality, there is an enormous disparity between designed capabilities and realized capabilities. While a temporary condition, we currently retain officer and non-commissioned officers less than seven and ten months respectively, and our current requirements for knowledge of cultures and languages would require years of exposure to specific cultures and complete facility with most of the major language families on the globe. One PSYOP organization had the responsibility for psychological estimates of some thirty countries lying generally in Eastern Europe, The Middle East, Africa South of the Sahara, and Central and South America. You can readily see that in the absence of tenure, in the absence of repetitive PSYOP assignments, in the absence of a field of specialization, we need massive help from the Human Factors Research Community. We have a proven methodology for application of Human Factors Research findings to our propaganda production. Armed with such findings we are able to identify and inject meaningful data into the decision making process and maintain the quality control necessary for effective propaganda. Our deficiency lies in the collection and collation of the data and production of finished studies on specific audiences. And, that specifically is where your help is critically needed. Our own research and analysis effort gives us a point of departure only. The general area studies and references from many agencies assist us greatly in reaching that point. And, we draw heavily upon the products of the Center for Research in Social Systems, upon the area studies facilities of supported commands, upon CIA, DIA, Department of State, USIA, USAID, and others. However, such massive assistance presents a major problem in itself. None of the products reflects the currency, and specificity required in our estimates. The collation problem facing the Research and Analysis Element would be enormous under ideal circumstances. Faced with the severe personnel turbulence and the extremely short retention rates, absence of repetitive assignments described before, our people can barely become familiar with the plethora of material before they are lost to us. Yet, our man must assess the political and psychological situation in the operational area. And, the adverse impact of brief exposure to PSYOP is finally compounded by the current trend for one year assignments in hardship areas.

So far we have considered only our capacity to advise and assist the supported commander. Now, let's see what happens when we receive our mission -- hopefully a mission which is consistent with our recommendations and not one as most frequently has occurred in the past -- to conduct PSYOP.

At this juncture the resources internal to the PSYOP organization go into high gear. We may have been charged in our mission statement to explain the U. S. military presence, encourage enemy defections or slowdowns, persuade the population to accept the inconveniences accompanying military operations and develop loyalties for a new and uncertain regime, encourage reporting of arms caches and -- particularly in Revolutionary Development -- we may be charged with the mission to inspire a concensus of public responsi-

bility, motivate public participation in nation building, to publicize our civic action projects (which incidentally we should have helped to select, basing our recommendation on what attitudes or behaviors should be influenced thereby.)

Assigned such missions, we must produce the propaganda required to achieve the desired effect. We must be able to select the appropriate medium and that combination of words, symbols, and even colors that will facilitate propaganda communication. Such selection is not easy. We have frequently failed. We must know the accessibility of the audience to the media available. In this respect we are fortunate for we have an impressive array of media to draw from and therefore great flexibility of choice. But the choice ultimately depends upon many facts outside of our control: The literacy rate among the intended audience may dictate use of printed media -- when we are concerned with a literate population -- or preclude the printed word when communicating with illiterate audiences; the types and density of radio receivers will influence employment of propaganda radio as will the listening restrictions present in the target area; the limitations on access, particularly in denied or uncertain areas, could restrict our use of audio/visual equipment; the many conditions influencing air operations - from weather to enemy air - will influence our use of aerial platforms for our loudspeaker broadcasts and leaflet dissemination. Mechanical and technical problems we can contend with. It is in determining what to _say_ over our radios, to _print_ on our leaflets or _say_ over our loudspeaker, that the problem intensifies greatly. Here again your contribution is critical. We must appeal to people, persuade them to listen to or read our messages often at the risk of their lives, cause them to identify with us or their government, accept the enormous inconveniences, change their loyalties, cause them to surrender, to defect, or to cooperate. We must implant new ideas, inspire hope, encourage suspicion of the enemy regime, in short, cause them to adopt behaviors compatible with our interests. And, we must do these things despite an unrelenting campaign on the part of the enemy propagandist - often accompanied by violence and terror- to cause them to adopt behaviors contrary to our interests.

Our arguments and appeals must be better than the arguments and appeals of the enemy. Our messages must address the problem of the audience, they must be personalized to the extent of making the group realize that we have the group's interest at heart, that the solutions we propose are consistent with reality both in terms of our intention and ability to do what we say we will do and in terms of their ability to act in the way we desire.

We must know people and not just the enemy. We seek universalities of behavior that apply generally throughout cultures. Some have been identified. We need human factors guidelines that will accommodate rapid evaluation of a psychological situation where there is little or no time for detailed study. We need those guidelines on the nature and extent of differences between ourselves and our audience that will permit persuasive intercultural communication and reduce the margin of waste and error. We need to know how we can communicate our intentions so as to minimize the chance of being misunderstood and, conversely, to

increase the probability of being understood.

Since we, like you, are always conscious of budgetary pressures we must have manageable and convincing measures of PSYOP effectiveness. And, it would be most useful if comparisons could be drawn between the relative effectiveness of operations conducted without accompanying PSYOP and those conducted with PSYOP. We need those guidelines, expressed in lay terms, so they will be usable by nonacademicians. And, what we are asking for is not limited to PSYOP in application. These data are vitally needed throughout the decision making apparatus of government. On this permit me a brief departure from my emphasis on PSYOP.

The missing ingredient in contemporary threat modeling is - I would submit - the attitudinal factor. This omission is nowhere more critically important than in the sophisticated forecasts of conflict environments. All such forecasts, although constructed from scientifically acquired data, appear t omit the one element that more than any other gives the final go, no go signal to the employment of a weapons system. And, this is the probable attitudinal and behavioral responses - which translate into political pressures - at both the sending and receiving ends of such systems. Developers of threat models accept the fact of that limitation; but allege that the very vastness of ignorance and the absence of proven methodology in attitudinal research prevent the input of meaningful attitudinal data.

I contend that ignorance and inadequate methodology have historically inspired research, not impeded it. I contend further that those input limitations are overly exaggerated and that limitations, however real, should motivate us seriously to accelerate our efforts to acquire the necessary intelligence. I contend that - without reliable human factors research - threat modeling, conflict environment definitions and decision making at all levels will continue to include incredible costly miscalculations.

In all these efforts and to a yet unappreciated extent throughout the entire decision spectrum from the infantry squad or Peace Corps outpost to the Honolulu or Manila conference tables, program and policy development has proceeded - albeit morally and sincerely undertaken - has proceeded without I feel a sufficient basis for anticipating even short-range attitudinal and behavior (political) impacts upon foreign and domestic populations not to mention long-range ones.

We psychological operators are but one of the categories of people whose effectiveness is dependent upon human factors research. Considering the whole of government, there is an enormous need. What is being done by you human factors research scientists could well be crucial to the preservation of our way of life.

Thank you.

SESSION 2
HUMAN FACTORS IN INFORMATION PROCESSING AND TARGET ACQUISITION

Chairman: Joseph Zeidner
U.S. Army Behavioral Science Research Laboratory
Washington, D.C. 20315

A. HUMAN FACTORS IN IMFORNATION PROCESSING AND TARGET ACQUISITION: Joseph Zeidner

B. SYSTEMS DEVELOPMENT AND RESEARCH NEEDS - HUMAN FACTORS IN ADSAF DESIGN John A. Ely, Colonel, USA, U.S. Army Automatic Data Field Systems Command, Fort Belvoir, Virginia 22060

C. MEASUREMENT OF TACTICAL MILITARY INFORMATION FLOW: Richard L. Krumm, Bunker-Ramo Corporation, McLean, Virginia 22101

D. HUMAN FACTORS RESEARCH IN TACTICAL COMMAND SYSTEMS: Seymour Ringel, U.S. Army Behavioral Science Research Laboratory, Washington, D.C. 20315

E. VARIABLES OF INTEREST IN DISPLAY SYSTEM RESEARCH AND DESIGN: Joel N. Bloom, Carl A. Silver and Mrs. Adele Farber, The Franklin Institute Research Laboratories, Philadelphia, Pennsylvania 19103

F. TACTICAL INTERPRETATION OF IR AND SLAR IMAGERY: Thomas Jeffrey, U.S. Behavioral Science Research Laboratory, Washington, D. C. 20315 (Note: This is a classified paper. Qualified persons may obtain a copy by submitting a request, and demonstrating a "need-to-know," to: Commanding Officer, Behavioral Science Research Laboratory, Washington, D.C. 20315.)

G. THE EFFECT OF ACQUISITION PARAMETERS ON AIRBORNE IMAGERY CHARACTERISTICS (unclassified abstract): Joseph A. Levy, U.S. Army Electronics Command, Fort Monmouth, New Jersey 07703

H. (BANQUET ADDRESS) COMMENTS ON SOME OF THE RESEARCH AND TECHNOLOGY NECESSARY FOR THE ENHANCEMENT OF HUMAN PERFORMANCE FOR MILITARY OPERATIONS: The Honorable Donald M. MacArthur, Deputy Director (Research and Technology), Office of the Director of Defense Research and Engineering, Department of Defense, Washington, D.C. 20310

2A. HUMAN FACTORS IN INFORMATION PROCESSING AND TARGET ACQUISITION

Joseph Zeidner
U.S. Army Behavioral Science
Research Laboratory
Washington, D.C. 20315

In this afternoon's session we will be concerned with information processing within command and surveillance systems. Both command and surveillance systems have much in common with intelligence and other types of information systems. As intelligence systems they are concerned with drawing inferences about the functioning of organizations or objects, and about the environmental context in which the objects or organizations exist. As information systems they deal with actual events which can be verified directly.

While a very important problem for command or tactical operations and surveillance systems deals with storage and retrieval of available data, a problem of greater complexity is introduced by the commander's and intelligence officer's need to draw inferences. The complexity arises because of the nature of the raw data being received and the manner in which it is processed. The data received may vary widely in volume, content, form, and reliability. In processing the information, attention needs to be given to different user requirements, severe time limitations, fluctuations in work load, and the possible importance of seemingly trival events. Because of such complexities these types of systems, more than any other type of information system, must be planned around the man, carefully taking into account his capabilities and limitations.

Unfortunately, much of the skill we have acquired in the specification of information systems has arisen from experience in developing actual systems. Since a system may have a development cycle that covers a span of many years before implementation, it is often very difficult and costly to introduce changes even though they may greatly enhance system performance. It is widely recognized that a methodology is required to rapidly manipulate a large number of variables simultaneously. Employment of such a methodology would not only facilitate laboratory experimentation on future systems, but also permit introduction of change early in system develop·.ent.

Many scientists have advocated the employment of computer simulation as a powerful tool for this purpose. It is recognized that such simulation is generally most applicable in solving hardware design problems. The systems under consideration in this session require a much greater

focus on software and the interaction of man with both the hardware and software. The equations for such computer models require human performance parameters. Much computer simulation work in the past has been, for the most part, either invalid or inaccurate because of poor estimates of human performance. Merely employing a wide range of parameters and iterating solutions can only produce rankings of system design alternatives that may be no better than the usual guess work. This is likely to continue to be the case in information simulation studies until human performance data can be provided. Of course, human performance data are also required to check the worth of simulation data, a necessary procedure often ignored.

One general objective of this session is to attempt to convey the relationships that human factors scientists have with other types of specialists in developing information systems - i.e., those generating initial requirements, the system users, the engineers, and the operations research analysts. A second general objective is to indicate the nature of the product human factors scientists provide in support of existing systems, those under development and those to be specified in the future.

In COL Ely's paper we are given a general description of the Tactical Operations System (TOS) currently under development in Seventh Army, Europe. He carefully isolates a number of important human factors problems within the specific setting of TOS. He directs our attention to several critical problem areas that have been untouched to date and also urges us to look at some of the basic organizational problems in the coming era of extensive automation. He cogently argues that "we must consider in detail the system with regard to the human, as the system can more readily be changed."

Dr. Krumm has been concerned for the last several years with the problem of comparing the performance of the automated Tactical Operations System in the Seventh Army field environment with the current manual system's performance. He details for us an approach of deriving relatively unchanged test results in a poorly controlled dynamic test environment. He analyzes findings in terms of information processing functions of the system such as dissemination, data retrieval, compilation and computation. In measuring system performance he distinguishes between responsiveness in transporting messages and the preservation of information quality parameters. Dr. Krumm's ingenuity is highlighted as he elaborates on the measurement of information quality in terms of "information clusters" on associated data items which yield a complete description of an event.

In Mr. Bloom's penetrating analysis of information displays, he focuses on the problem of what the commander does with his information rather than on the problem of how the decision-maker obtains his information. The "goodness" of a display is indexed by how efficiently and wisely the information is used. Displays measured in terms of extractive indices such as search time, completeness and accuracy do not address themselves to the more fundamental aspects of the decision process. Mr. Bloom analyzes the more subtle aspect of display systems in which the concern is with communication-related variables or as he calls them, "the people dimensions." He describes a model to help understand the human filtering operation employing such concepts as physical distance, psychological

distance and organizational distance as relevant effectiveness measures.

Mr. Ringel has been concerned for a number of years with a research program directed at improving the effectiveness of tactical command-control systems. In his paper he describes the organization and progress of a portion of this program and presents a sampling of study findings. A very significant feature of Mr. Ringel's program is the balance employed in maintaining experimental control in relating study conditions to the field situation. It is worth noting that Mr. Ringel's laboratory facilities employ the same hardware as that used in the Seventh Army TOS. The TOS development is used as a point of departure for experimentation leading to recommedations for future systems. At the same time, an attempt is made through a field-unit co-located with the TOS Development Group to work on problems that might be immediately applicable to the current system.

In Dr. Jeffrey's and Mr. Levy's papers our attention is turned to studies dealing with the extraction of intelligence information from aerial images. A general objective of both papers is to determine how performance of interpreters is affected by acquisition parameters. This highlights the dependence on performance parameters as a means of improving design of sensor systems. Similar types of performance data also are useful in revising doctrine, operations, working procedures and training. Consequently, the CRD has supported for a number of years a human factors research program. This program has been closely tied to surveillance activities of ACSI, CONARC, the Intelligence Center, and the Surveillance Laboratory of AMC.

Dr. Jeffrey's study explores the ability of interpreters to use SLAR imagery in detection and identification, and also their ability to use MTI returns to detect moving vehicles. He systematically describes the research paradign used in obtaining experimental evidence. His findings have important implications for all phases of the surveillance information extraction process. They point to the need to identify techniques to more fully exploit existing operational capabilities.

Mr. Levy is involved in a research program exploring the effects of imagery acquisition parameters on the physical characteristics of the image. He emphasizes the importance such data have in specifying the conditions of sensor deployment and on the interpreter's performance. He reviews both theoretical considerations and the results of empirical studies. He also shows a number of interesting examples of how infrared and radar images are affected by environmental and acquisition factors.

From this brief review, I think you can see that we are attempting to present a composite view of problems and approaches to their solutions as seen by contributors representing technical management, industry, and in-house laboratories.

2B. SYSTEMS DEVELOPMENT AND RESEARCH NEEDS – HUMAN FACTORS IN ADSAF DESIGN

John A. Ely, Colonel, USA
U.S. Army Automatic Data Field Systems Command
Fort Belvoir, Virginia 22060

BACKGROUND

ADSAF

The Army is engaged in development of automatic data processing systems to assist tactical commanders and their staffs in the planning and conduct of military operations. The project known as Automatic Data Systems within the Army in the Field (ADSAF) is conducted by the Automatic Data Field Systems Command, a sub-element of both the U. S. Army Combat Developments Command and the U. S. Army Materiel Command. ADSAF includes three ADP systems, all aimed at improving human performance. The logistical and administrative support system is the Combat Service Support System (CS3); the tactical systems are the Tactical Fire Direction System (TACFIRE) and the Tactical Operations System (TOS), assisting the functions of fire support and maneuver respectively. All of the systems emphasize use of source data automation, storage, and retrieval of information, computation, and assistance in the dissemination process. All are also involved in the decision making process. This is particularly true of TOS which will be used as the vehicle for this discussion concerning the kind of human factors information required for the ADSAF project.

TOS

The TOS is an ADP system which assists commanders and staffs at the Field Army, Corps, Division and lower echelons in the broad functional areas of operations, intelligence, and fire support coordination. Computer centers with the data base are located at Army, Corps, and Division main command posts with input-output devices at major subordinate information gathering and using elements. Principal elements of the system are computer centers with peripheral devices, remote station data terminals, and user input-output devices (UIOD). These UIOD are cathode ray tube (CRT), using fixed format data messages, queries, and responses. A major developmental effort for TOS has been under way in Seventh United States Army in Germany since 1964.

HUMAN FACTORS IN GENERAL

The Human Role

Key words in the TOS definition are "ADP system" and "assists the commanders and staffs." The TOS is not a Command and Control System per se; it is a part of the command

and control system which is essentially composed of the commander, his staff, and operational procedures supported by communications and other systems whereby the command and staff functions are exercised. This support role makes TOS a tool of the human, and in no sense his master. People are ascendant and are engaged with TOS in two general ways. They are organic to the system, or they contribute data to the system and are served by it. Stated another way, they are the people who operate and maintain the system and the people who input information and use the output. The limitations, foibles, and complex influences of these people on the functioning of the system dictate research to assess human factors impact on system design.

Environmental Influence

With respect to tactical systems such as TOS, we must consider influence of the echelon or level of command involved on the human factors, i.e., the organizational and operational environments in which the system will operate. Some basic general considerations are that the lower the echelon, the shorter the required reaction time and the more difficult the physical working environment. Also, as we go lower in the command structure we find that the level of education and technical capability generally becomes lower. The information elements at higher echelons are generally more complex and the costs of major error are usually greater. For various reasons the stability of personnel assignments appears greater at higher echelon. Also, it would appear that the complexity and power of equipments now available at lower echelons have outstripped the capabilities of human resources available at these levels to exploit their full value. From the above, it follows that in designing an ADP system to assist the entire chain of command the differences in echelon must be considered in light of the real world. With respect to human factors then, one must establish as nearly as possible what the real world is like at various echelons so that the constraints within which designers must work can be established. Criteria must be established for measuring human performance which reflects the capability of the human to operate and use the hardware and software components of an ADP system such as TOS. Using results of measuring human performance by these criteria, the trade-offs required at various echelons because of the limitations of available human resources can then be made. This must consider the competition for talent growing out of the existence or planned use of other relatively complex systems. In order to make comparisons then, the performance criteria should be correlatable to similar criteria for other complex systems, particularly where hardware and operating procedures complexities are definable in similar terms. In summary, we must establish the means for defining the human factors realities likely to be encountered in the various organizational and operational environments and then limit design complexity accordingly. Such an examination must consider the human factors impact of full mobilization, as well as the relatively ideal circumstances of a limited involvement. These criteria of human performance would desirably be related to such things as equipment operation, equipment maintenance, information formatting and handling, computation, collation, assimilation, recollection, span of control, and, hardest of all--decision making. Application of these criteria to various echelons should help in the establish-

ment of a description of the people at each echelon toward whom design should be directed. Such a process has been intuitively applied, for example, in designing the developmental TOS in Seventh Army to favor pre-formatted reports and queries by user input-output stations. It has been presumed in this case that to plan the use of complex procedures needed for a more sophisticated approach would not be realistic.

HUMAN FACTORS IN DESIGN

General

The discussion above deals, in general, with defining and measuring the human with respect to a type system primarily in terms of limitations. But we have a "chicken and egg" situation--we must also consider in detail the system with respect to the human, as the system can more readily be changed. The system's effectiveness is primarily reflected in its output and the usefulness of that output to the human user. In the TOS the output is information, the characteristics of which have been defined as timeliness, completeness, accuracy, and validity. None of these characteristics have meaning unless they can be connected with the human. Further, output is dependent on input, and input is a function of a human action. We thus reinforce the conclusion that the human is the key to successful design. Information is needed with regard to the characteristics of the specific type of human from whom the system accepts information and to whom it outputs information.

Input

With respect to input, we should determine how man communicates in the tactical environment and its effect, e.g., what are the human reactions to voice communication versus an alfameric presentation? The study of influences of these factors should indicate to designers such things as whether methods of emphasis should be incorporated into input devices such as underlining, outsize letters, exclamation points, or other techniques to make up for the lost impact of voice equivalents in alfameric representation--or should all messages of immediate and urgent import be duplicated by voice? With respect to digital input formats using a key board and CRT, is the standard typewriter keyboard organization best? What format type is most efficiently filled in by the human, and is easiest to visually check for accuracy prior to transmission? Such areas of examination could, for example, indicate to the designer that the most significant content of a message should be entered first, with header, evaluation, and other elements last, even though transmission may be in a different sequence. Another type of answer which could result would be that a box should be used for mandatory entries and an underline for optional entries in the format.

Any information system is influenced by the play of human factors in source data accuracy. These are particularly important when direct contact with the source is missing. The effects of fatigue and stress on accuracy of combat reports may be so marked as to warrant some compensating design feature. Knowledge of the predominant types and the causes of human errors generated at the source of information will enable designers to consider these and reduce their impact. In the TOS, for example, the interplay of the user input-output device, the military grid referencing system coordinate, and the human operator (brigade level sergeant) would appear a good area

for investigation. Such study should, for practical reasons, assume that neither the map coordinate system nor the human will change soon, but that the procedures and other elements of system design pertaining to the data input process can, and should, change as revealed necessary. For example, it could be determined that in handling the coordinate NA 593625 the brigade level sergeant can, from his knowledge, detect an error in the NA 5--6-- 95% of the time but that errors in the second and fifth numerics are detected only 30% of the time, and in the third and sixth, seldom detected. It might further be shown that the nature of errors in the third and sixth digits is most frequently transposition. With information of this kind procedures and techniques for error detection and correction by the system can be designed more effectively.

Another area of examination of the human in the input process deals with the level of complexity of the input process at the point of translation from hard copy or voice to the digital data input. For example, what is the point at which, in dealing with various codes and abbreviations, the battalion level sergeant becomes ineffective, e.g., what is his ability to use codes, code-books, or indices of forms? This kind of information will assist, for example, in determining the limit of use of code-book oriented procedures and whether or not a requirement exists to automate the index of formats with which a given operator deals.

System Operation

No matter how efficiently the input procedures and design are structured the processing part of the system must operate effectively to produce output which we identified as the ultimate criterion of system effectiveness. To physically operate and maintain the systems of ADSAF the same human factors applicable to design of any complex electronic equipment appear significant. Therefore, in this discussion, these are mentioned only to emphasize the fact that human engineering must be applied in equipment development and also that in determining the human factors influence, the echelons of use must be addressed.

While the human factors aspect of physical operation and maintenance is not particularly unique, that of system management or control appears new. It has been said that timeliness, accuracy, completeness and validity of information output to the user are characteristics which must be evaluated against the human user. One of the most important of these people--sort of a user operator--is the system controller or manager. How long does it take him to react to a given type warning and take the necessary corrective or preventive action? How accurate and complete can his knowledge be of the operations in progress, i.e., of system status? What information concerning status is relevant to the controller? This type of information can aid the designer in determining the type or types of alarm to signal system malfunctions or the approach of some critical condition, such as a full queue or exhaustion of storage. The controller's capability to absorb the volume and detail of status information will define the upper limit of the detail of his control and the relevance to him will assist in defining his duties or dictate a division of duties among multiple controllers. This kind of information will also assist in design of the operating system for override by controllers, for purging files, and for changing processing priority.

The human factors influence of the controller will determine who monitors what, and how they use the information gained from monitoring. Obviously, the detailed monitoring performed by a programmer in debugging his program is not appropriate to a system monitoring function--but what level of detail is appropriate, about what things, within human limitations? These human limitations, with regard to time, accuracy, scope, and ability to make sense of status information, are probably the real constraints on system control design to include the manual procedures to be used in system control.

Output

The interplay between the user and the system output measures the usefulness of the system. The system should be designed to communicate in the best possible way with the user, both in transmitting basic data and in reporting change. In this regard, the use of graphic and alfameric display, as well as audible signals, should be explored for various types of information at various echelons. This will establish features desirable in output design such as the use of color, identification of change, the need for totes, hard copy, historical summaries, and the like. For example, the good commander is in his command post only periodically. At this time he must be brought up-to-date rapidly. The techniques for doing this most effectively must be incorporated into system design. Further, we know that commanders have applied mental factors in assessing estimates by various subordinate units. Can we, in system applications, give him the capability to selectively apply such personality factors to the processing of data output for more refined estimates--or is this desirable at all? To increase a decision maker's certitude, the manner of showing information reliability and estimated accuracy should be reviewed. For example, should a space be provided in message formats which will identify personal involvement of the commander sending the message--and does this have major significance to the recipient? Is the current intelligence information evaluation system sufficient, or should refinements or aggregations of this be used? Must the decision maker be provided a means for analyzing the rationale of a machine collation, and to what degree?

ADP Impact

Finally, some people think the automated information system presents strong arguments for centralization of control of operations. There are strong arguments to the contrary which include consideration of human limitations, synthesis of information, and error detection and correction capabilities. After all of the less complex aspects of human factors in system design have been addressed, the examination of this facet of the centralization problem could, perhaps, result in a real breakthrough in solving basic organizational problems in the coming era of extensive automation.

SUMMARY AND CONCLUSION

The project manager and the designers of ADSAF need human factors information of the type herein described, and much more. Certainly much work has been done, or is in progress in the required areas; however, they need to be pulled together into a basic reference for designers. Further, the results of studies, to be useful, should be synthesized and clear in their conclusions and contain recommendations reflecting scaled alternatives for the human factors relationship to design characteristics. For

example, in a particular display application, color may be required for the highest degree of effectiveness of man-machine communication (weighted value: 10), with shading next (weighted value: 9) and underscoring next (weighted value: 4) at the worst level might be written words in standard type (weighted value: 1). Using these scaled characteristics, the managers and designers can cause proper trade-offs to be made, resulting in the most practical state-of-the-art design within technical and project funding constraints. The system designers and managers look to the human factors and behavioral science experts for this kind of guidance. It is needed to ensure that the hardware, software, and procedures of the automated system produced will interact most effectively with the paramount ingredient in, and user of the system--man.

1. ADFSC Comparative Efficiency Measurement of Seventh U. S. Army Manual and Automated Tactical Operations Systems, 30 June 1967, prepared by Bunker-Ramo Corporation.

2. Department of the Army ADSAF Implementation Plan, 11 May 1965, with changes.

3. ADFSC Initial System Description, Seventh Army Provisional Tactical Operations System, September 1966, prepared by Bunker-Ramo Corporation.

4. BESRL (APRO) Man in Command Information Processing Systems--A Research Program, July 1963.

5. BESRL (APRO) Information Assimilation from Alpha-Numeric Displays--Amount and Density of Information Presented, April 1964.

6. BESRL (APRO) Certitude Judgments and Accuracy of Information Assimilation from Visual Displays, May 1964.

7. BESRL (APRO) Conspicuity Coding of Updated Symbolic Information, May 1965.

2C. MEASUREMENT OF TACTICAL MILITARY INFORMATION FLOW

Richard L. Krumm
Bunker-Ramo Corporation
McLean, Virginia 22101

BACKGROUND

General

The Department of the Army is developing several automated data processing systems for use within the Army in the field. One of these systems is the Tactical Operations System (TOS). Since October 1964 the major effort in developing the TOS has been made in Seventh U.S. Army located in West Germany in order to use a realistic environment to develop a system which will meet tactical military staff needs at the levels of field army, corps, division, and lower echelons.

Hardware

The initial hardware increment for Seventh Army consists of one transportable Central Computing Center (CCC), four Remote Station Data Terminals (RSDT), and 18 user Input/Output Devices (UIOD). The CCC is a Control Data Corporation 3300 computer. The RSDT's are Control Data 1700's, which provide a switching and buffering capability. The UIOD's are combinations of CDC 1584 typewriters for message output, and a Control Data QSE 1384A consisting of a CRT display and a keyboard for input message composition and insertion. The CRT can also display output messages in "soft copy" which can then, at the user's option, be rejected or can be switched to the typewriter for a "hard copy" output. The transportable CCC is housed in three 35-foot expansible vans and one 40-foot van. The RSDT's are a truck-mounted; two 2 ½ ton vehicles being required to house the computer, the automatic encryption/decryption devices and the air conditioning equipment. The UIOD's are desk-top devices and will be located in each using staff element area within the Tactical Operations Centers.

Software

The system software is being developed by The Bunker-Ramo Corporation in accordance with a modularized, parmeterized, table-driven design concept. The design intent is to maximize system flexibility and modification capabilities as experience in using the system indicates which changes may be desirable. Very briefly, the software consists of an Executive Program which edits messages, schedules their processing, formats

the output messages, etc.; a number of Special Processes, such as coordinate conversion and numeric encoding; and (in the initial increment) four Functional Area Capabilities concerned with the topic areas of Enemy Situation, Friendly Unit Information, Nuclear Fire Support, and Effects of Enemy Nuclear Strikes.

Functional Area Capabilities. Enemy Situation pertains to the identification, description, location, activities, and capabilities of the enemy force, including air capability.

Friendly Unit Information pertains to actual or planned changes in the tactical disposition, status, activities, and task organization of combat, fire support, and combat support units.

Nuclear Fire Support provides for the processing of information concerning the status of nuclear fire missions and nuclear allocations.

Effects of Enemy Nuclear Strikes provides information concerning predicted and actual effects of nuclear strikes. It provides a capability for the computation of effective winds, radii of damage, fallout patterns, radiological contours, vulnerability (pre-strike estimates of damage effects and fallout patterns), and accumulated dose and leave time.

Message Types. Each of the above "functional areas" contains four operational message types.

1. Data Input, Data Change, and Data Delete Messages.

a. Enemy Situation
- Enemy Units
- Enemy Weapons and Equipment
- Enemy Installations
- Enemy Fortifications and Obstacles
- Enemy Boundaries and Battle Lines
- Enemy Loss
- Enemy Weapons and Equipment Losses

b. Friendly Unit Information
- Task Organization
- Task Force
- Center of Mass
- Command Post Location
- Boundary and Deployment
- Front Line Trace
- Operational Activity
- Unit Status

c. Nuclear Fire Support
- Nomination
- Target Analysis
- Approval/Disapproval
- Fire Order
- Expenditure
- Post-Strike Results
- Request/Command
- Request/Denial
- Allocation

d. Effects of Enemy Nuclear Strikes
- Winds Aloft
- Fallout Metro
- Report of Nuclear Strike
- Radiological Readings
- Aerial Readings
- Decay Rate

2. Query Messages. The entry of a valid query initiates a search of the data base. The extent of the search is controlled by the contents of the data input messages indicated above and by the retrieval criteria which the user specifies in the query. When the data base has been examined and an answer obtained, the query is voided automatically. If the requested information is not in the data base, a negative response notice is sent to the requester.

3. Special Process Requests. These request the performance of a computational or a compilational process using data base information and parameters included in the input request message. Certain of the special process output messages (e.g., Situation Report and Intelligence Summary) may be periodically generated without the continued insertion of request messages. Examples of special process output messages are: for Friendly Unit Information, the Situation Reports and Front Line Trace Messages; for Enemy Situation, the Intelligence Summary; for Nuclear Fire Support, the Allocations Summary and the Weapons Summary; and for Effects of Enemy Nuclear Strikes, and Decayed Contamination, Accumulated Dose/ Leave Time, Effective Wind, and Pre-strike Effects.

4. Relay Messages. The TOS user can also transmit free-text messages to one or more system users. The relay message bypasses the data base. Except for the message heading, there are no restrictions with respect to format and content requirements.

Staff Elements. The staff elements served by the initial hardware and software increments include the operations and intelligence elements; the fire support coordination element; and the chemical, biological, radiological element at army, corps, and division levels. The user personnel include the commander and senior staff and the action officers and non-commissioned officers in the above-mentioned staff elements. The system operating personnel include an RSDT operation team at each military unit served by the system and an operation team at the Central Computing Center. In addition, system controllers provide an overall system management capability.

Communications. The CCC and RSDT's are linked by the existing Seventh Army communications system. The UIOD's within the secure Tactical Operations Centers are connected by cables to the RSDT and each RSDT communicates, encrypted, with the CCC via a 3 kc voice channel. Two communication frequencies are employed, one to be used for backup.

Testing Sequence. As each software module is developed, it is debugged and checked out by the software programmer. These checkouts include, in their later stages, limited integration checkout of groups of modules. Upon successful completion of these checkouts, a series of Software Design Verification Tests is conducted to verify proper software functioning in accordance with design specifications. Testing attention then turns to integrating the other portions of the system, including field testing of communications adequacy and the adequacy of training of user and operator personnel. These limited-scope tests culminate in System Design Verification Tests conducted in a field environment to verify the proper integrated functioning of the entire system: software increments, transportable hardware, communications, personnel, and operating procedures. After this sequence of tests, the testing interest turns to TOS evaluation. These evaluations will be conducted under the auspices of USAREUR/ Seventh Army and will range from comparisons of aspects of manual system and automated system capabilities to evaluations of the operational usage of the TOS in tactical situations. The comparative tests, which are the topic of this paper, will consider whether the automation of certain information processing functions results in substantial improvements in

efficient information flow.

THE PROBLEM

The field testing task is to compare the performance of an automated tactical operations system in a field army environment with the current manual system's performance. Specifically, within the testing constraints imposed by the incremental delivery of automatic data processing equipment, the incremental design and development of specialized software, and the desirability of adhering to Seventh Army's normal field exercise schedule, develop a testing procedure which will permit at the earliest possible date a quantitative indication of the relative merits of the automated and manual systems in efficiently processing tactical military information.

APPROACH

The present system evaluation effort has been organized around three central concepts. The first is that the possibilities of deriving relatively unbiased test results in poorly controlled dynamic test environments can be maximized by analyzing the findings in terms of information processing functions. Secondly, the system performance measures are defined to distinguish between characteristics of the information processing system and characteristics of the information which flows through the system. And finally, the quantification of amount of information transmitted can be defined to include "meaning," or the "intelligibility" of the messages.

Data Processing Functions

The system evaluation effort stresses the comparison of the two information system processing efficiencies in terms of their accomplishment of four data processing functions: dissemination, query response, computation, and compilation. It is felt that this strategy will be relatively insensitive to test situation effects since these data processing functions are common to all TOS software areas and are applicable to each military staff element of interest. Therefore, the effect of transient variations which may be experienced during field tests should have approximately equivalent effects on each function. Although such effects will contribute to the total error variance, there should be no systematic bias.

Dissemination. This refers to the capability of transporting information from a data input source to one or more geographically separated users. In a manual system this is accomplished by using radio nets where users monitor common frequencies, and by using teletype facilities, telephone, and couriers. The automated system provides dissemination capability by direct routing (relay messages addressed to specific recipients designated by the sender) or automatically by comparing processed data with subscribers who have established "Standing Requests for Information" (SRI).

Data Retrieval. This refers to the accessing of a data file in response to a request to select and report specific information. This function is similar in nature for both a manual and an automated system although the information will, of course, be differently stored and accessed.

Compilation. This refers to the function of extracting only specified information items from files. It necessarily involves "retrieval,"

but is regarded as a higher order effort since it implies multiple retrievals and a grouping or sequencing of related information items in the output message. In either a manual or an automated system the actions required to perform this function are similar. The function involves the search, identification, extraction, and sequencing of items from lists of items in accordance with clearly specified logic rules.

Computation. This refers to arithmetic manipulation which is required in both the manual and automated systems. This definition is necessary since ADP will often require a computation function which is not required in a manual system. (For example, a request for identification of all military units within a specified area can be satisfied in a manual system by a visual check of a situation map. The TOS requires a computational routine to manipulate geographical coordinates prior to "searching" the defined area. Since the computation function is not performed in both systems, this task does not qualify for inclusion in a comparative test of the computation function.)

The TOS messages were analyzed to determine which of these data processing functions are accomplished for each message type. Based upon this analysis, a sample of messages can be selected from those prepared by exercise controllers for use during an exercise. The sample of controlled messages which will be inserted will initiate the above identified data processing functions. Manual and automated system performance of each function can thus be separately scored and analyzed. To some it may appear that the results of this sort of analysis are preordained; i.e., machines are obviously faster in performing certain data processing functions. This is correct if one considers only the machine through-put time. However, the comparative testing interest is with a "system," i.e., the entire data flow from source to user, and, therefore, the possible advantages of ADP applications are by no means certain. For example, opportunities may sometimes exist for necessary input data to be incorrectly entered in the system, or for considerable time to be required to format and insert an input message correctly, or for communication channels to be blocked, or for output information to be incorrectly interpreted, or for complicated machine processes to be required to develop certain information which can be sensed at a glance by checking a manual system map display. For the above four information processing functions, the following system performance measures will be taken during field test situations and for each of the various message types which are common to both systems.

System Performance Parameters

Two major performance dimensions can be distinguished which are directly relevant to the efficiency with which an information processing system transports information. Information units are grouped and the resultant grouping is a "message." The message must be transported rapidly to its appropriate destination, and the quality of the information contained in the message must be preserved. For present purposes these two performance dimensions are termed "responsiveness" and "information quality."

Responsiveness in Performing System Functions.

1. Dissemination. For either the manual or the automated system, a measure of considerable importance is that of the elapsed time from the moment information is made available to the system until the message containing that information is disseminated to a user. The measure of system responsiveness in this case is the elapsed time from provision of the test message by the exercise controller to receipt of a relevant output message by the concerned action officer or officers.

2. Query Response. Problem situations often arise during tactical operations which require for their solution information which may not be locally available at the Tactical Operations Center. In such situations a request may be made for the desired information. In the manual system such requests may stimulate queries to subordinate, adjacent, or higher units. In the automated system many such problems may be resolved by inserting a query message to search the data base. For either system, responsiveness may be defined as the elapsed time from an action officer's expression of the query to the moment a usable response is received by him.

3. Compilation and Computation. These functions are special cases of the query described above, although they may be initiated in the manual system on the basis of Standing Operating Procedures rather than by an explicit request for information, and they may sometimes be initiated automatically in the TOS. In either event, and for either system, the measure of system responsiveness can be defined as the elapsed time from start to completion of the function. "Start" is defined as the time that a person initiates a request or begins to organize or manipulate data to produce an output message. Completion of the function is defined as the time the message containing the desired information is made available for dissemination to the appropriate action officer.

Information Quality Parameters. When a message is received by an action officer, there are at least three characteristics of its contents that are of immediate concern. The first is the timeliness of the information (the "as of time" relative to the current time). Secondly, he must assume that he has been provided with all the information currently available (completeness) and, thirdly, he must assume that the provided information is accurate. These characteristics of information quality are discussed separately below.

1. Timeliness. It is generally conceded that a primary requirement of an information system is that it provides information to a user as soon as possible after an event of interest has occurred. Thus, the timeliness measure can be defined as the time difference between event occurrence (the event "as of time") and message receipt at each appropriate command echelon. A brief discussion may be helpful to clarify the distinction between this measure of information timeliness and the previously discussed measure of system responsiveness. System responsiveness was defined as the elapsed time from, say, an action officer's expression of a query to receipt of an appropriate response. By

contrast, the timeliness of the provided information refers to its "staleness;" i.e., the elapsed time from the event "as of time" to receipt of the query response concerning that event. Similarly, system responsiveness in disseminating information is measured within TOS from the time a report of an event is received at the lowest TOS input echelon to the time the message concerning the event is received by a user. But the timeliness of the contained information is the message receipt time minus the "as of time" of the event. These will not necessarily be the same, and the distinction is important in evaluating system information processing effectiveness.

2. Completeness. Completeness can be defined as the percentage of data items present in an output message as a function of those made available by the exercise controllers. Measurement of the completeness of the information which is included in data messages presents a scoring problem which must be recognized. Within most automated data processing systems, permissible data codes are rigorously specified, and only those data codes may be used. The language of a manual system is far less restrictive. Consequently, evaluators must identify for each test message in the manual system the information units corresponding to TOS data codes which are permissible for that message type. These identified information units ("data items") will be the basis for deriving scores of information completeness for the manual system.

3. Accuracy. In measuring message accuracy, the basic unit of measurement will also be the data item. With this orientation, one or more incorrect alphabetic or numeric characters in a single data item will be scored as one error; and an incorrect data item, even though it is comprised of properly keyed characters, will also be scored as one error. This approach applies to the great majority of TOS messages wherein the basic unit of measurement will be the data code (corresponding to the data item for the manual system). TOS input formating constraints will require that most messages conform to fixed patterns where certain data codes are mandatory and some are optional. Since the variability of input is limited, the TOS Edit/Validation software program can evaluate the legitimacy of most data codes. Accuracy scoring in terms of TOS data codes will, therefore, be concerned with incorrect words or with numerical values which are still within the logic rules of the Edit/Validation software, and with data items in a free text message (which will not have been subjected to Edit/Validation checks). Such errors will still be related, of course, to the total number of data items transmitted in order to derive an error percentage score. In determining which data items are in error, the criterion in most instances will be the contents of the test message which was provided by the exercise controllers for input to the system. Thus, if a command post location is cited, the geographic coordinates must remain unchanged as the message is processed through the system. This scoring standard can be applied directly for all data messages, most query response messages, and most messages which result in compilations of data. However, a different set of standards is used for scoring the accuracy of data items that result from computations. In some cases

computational accuracy may be determined by the degree to which computations deviate from a true value. (For example, scoring of a predicted fallout pattern may require this orientation.) In other cases a true value may be established and tolerance limits specified so that computed values which fall within the tolerance are scored as correct and those which exceed the tolerance are scored as incorrect. (For example wind direction must be expressed in an Effective Wind Message within five degrees of the true value.)

To summarize, the primary standard of accuracy in evaluating either information processing system will be the message data items which are originally presented to the system input operator. The system output will be scored in terms of the data items which correspond to the input standard. This measure of accuracy is applicable across most message types and most information content for both systems. An exception exists for output messages which contain results of computations. For these, tolerance limits must be established to score the computations in terms of an approximate, rather than an exact, correspondence with true values.

Scoring of Information Quality

The comparative testing interests center upon the efficiency with which specified operational information is made available to the user. This information must meet strict and invariant requirements; for each message type only specified data items are to be scored and, within the TOS, these must be expressed in acceptable data codes. In this context, data item refers to one or more alphabetic or numeric characters, and is considered the most basic "unit of information" which can be transmitted through an information system. The data item is the standard unit for measuring manual system information quality.

Data code is a number, letter, symbol, or a combination of these, which is used in the TOS to represent the data item. This code is directly translatable; each code always stands for one particular data item. The data code is the standard unit for measuring TOS information quality.

Data items often gain intelligibility only when they are identified with respect to their use in the message. This identification can be accomplished by using a label ("DTG":180800) or it may be accomplished by the juxtaposition of related data items (PQ180800). The first example indicates that 180800 is a date/time group; the second that it is a set of geographic coordinates.

Moreover, it should be noted that the intelligibility of a message is also dependent upon whether the message contains a minimum number of data items which are of specified types. For example, G-2 and G-3 spot reports should contain, as a minimum, data items relating to "who, what, when, where." If any one of these data items is missing the entire message lacks intelligibility. If any one of these data items is inaccurate the message loses value. Such data items are defined as "associated data items" (ADI) and each such set of items is termed as "information cluster."

An example may clarify the necessity for distinguishing "information clusters" and will serve to introduce our approach to scoring data messages.

Assume that a fire fight is in progress. There are many aspects of the engagement that could be reported to higher headquarters. The local observer selects from the many possible aspects the ones he considers most important. The data items he reports are unitary only in the sense that they all refer to the one engagement. Thus, the following message might be transmitted from battalion to brigade:

"From Rover. As of 220900, 20th Mechanized Regiment attacked vicinity AX 7899. Friendly forces forced back and are now delaying along line from AX 8192 to AX 7580. Forty enemy KIA. Casualty report: 17 friendly KIA, 31 WIA."

Regardless of continuing developments at battalion, this message contains all of the information that is now available to brigade concerning the engagement. Several "information clusters" are identifiable:

1. Enemy Unit Activity
2. Friendly Unit Activity
3. Enemy Casualties
4. Friendly Casualties

Thus four separate intelligible messages could be sent, and each of these could be regarded as a single information cluster, as follows:

1. "From Rover, as of 220900, elements of the 20th Mechanized Regiment attacked vicinity AX 7899"
2. "From Rover, delaying from AX 7580 to AX 8192 under attack as of 220900"
3. "From Rover, 220900, 40 enemy KIA vicinity AX 7899"
4. "From Rover, 220900, casuality report: 17 friendly KIA, 31 WIA vicinity AX 7899."

Collectively, these four clusters reconstitute the information in the original message. Any single cluster indicates that an engagement has occurred and reports on but one aspect of that engagement. Any single cluster contains the information necessary for intelligibility. Therefore, the clusters could be transmitted separately as individual messages to, in this example, G2, G3, G2, and G1/G3, respectively. In that case, if any portion of a cluster were omitted, that particular message would lack intelligibility.

In the present manual system the original message received at brigade might be transmitted in its entirety to a staff element at division which, in turn, might retransmit it to corps (and might or might not distribute it to other staff elements at division). In any event, it would not be necessary to fragment the original message in terms of information clusters. Therefore, the efficiency of the system in preserving information quality could be measured simply by comparing the data items in the output message with those in the original report.

However, the TOS requires a different message scoring procedure. Unless the message is directly routed through the TOS as a single relay message (thus defeating a basic conceptual design of the sys-

tem) it will be necessary for an input operator to fragment the original report into several input message formats. These will be similar to the "information clusters" noted above since each TOS message format contains specified "mandatory" data items. The formats necessarily restrict the allowable content. Therefore, automated system information processing efficiency can not be measured simply by comparing an output message with the original message because there may be several different output messages each, perhaps, with a different set of recipients whose information needs are also different.

Now let us suppose that the original message were changed slightly to report that the enemy infantry attack was supported by three tanks. The reference to tank support is subordinate to the infantry attack and would not alone constitute a portion of an independent information cluster. A report, for example, of three tanks at a certain location, or three tanks attacking at a certain location, is not an independent aspect of the event being reported. Both the tank support and the infantry activity refer to a single enemy attack, and the reference to tank support is subordinate to the major message. Thus, the reference to three tanks in support does not constitute a separate information cluster. It is necessary, therefore, also to define procedures to score this kind of information element. Or, in general, to score any such modifying data item (MDI) which is subordinate to an information cluster. For example, an original message could refer to an artillery barrage and might contain a modifier such as "heavy," "concentrated," "intense," "intermittent," or "occasional." Inadvertent deletion or change of the adjective modifier will not render the message unintelligible but it will certainly alter the description and a recipient's understanding of the seriousness of the event. Similarly, if an enemy unit in attack is reported as "tank division" rather than "XXth tank division" the message still conveys the meaning of the event even though potentially valuable information in terms of the identifying modifier has been lost.

From the foregoing it can be seen that the measurement of information quality is more than a matter of counting the number of data items which were transmitted, or which were transmitted correctly. That sort of approach is based on the tacit assumption that data items are equivalent in terms of their contribution to the descriptions of events.

It has been shown that some data items (defined as ADI) are intelligible only in combination, that the absence of one can render an entire message unintelligible. Consequently, the measurement of information quality in tests of the Seventh Army TOS will be concerned with the transmission of "information clusters," i.e., associated data items which collectively describe one aspect of an event, and with modifying data items which relate to given information clusters.

It should be noted that a data item in an initial description of an event may be incorporated in one or more "information clusters." This is particularly true for data items relating to time and location. In effect, a measurement scheme based upon information

clusters gives added weight to such data items as time and location for any events which are described in terms of several aspects. This weighting is not objectionable since testing control can be exerted over the types of messages which will be used during field tests and an unbiased scoring procedure is, therefore, attainable. Although their data content may differ from test to test, the test messages to be used during a given exercise can be selected in terms of the number of their contained information clusters, associated data items, and modifying data items.

During preparation of the test messages the data items should be organized in terms of the information clusters contained within each message, and data items modifying the clusters should be identified. Each cluster can then be assigned an *a priori* value which is the number of its contained data items plus the number of its modifying data items. These are summed to arrived at an *a priori* value for the original message.

Scoring is accomplished by first checking the output message to ascertain that all "associated data items" (ADI) are present for each information cluster. If any one is missing, the completeness score for that cluster is zero. If the ADI's are present, the completeness score is the number of data items in the clusters plus the number of data items in any modifiers which have also been transmitted divided by the *a priori* value of the message.

This scoring technique permits interpretation of the measure of completeness as being responsive to the question, "of the total relevant information which is available and capable of being processed by either system, what amount is actually transmitted to specified system users?"

The above example identified one possible information cluster as that containing associated data items relating to "who, what, when, where" in a spot report. Other types of information clusters could also have been defined for other types of messages. The important consideration is that the various clusters, however identified, be similar in test messages employed within both information processing systems being tested.

SUMMARY

Comparative testing of the Seventh Army TOS and the current manual tactical operations systems is concerned with the relative efficiency of the two systems in performing the information processing functions of:

1. disseminating information to relevant users,
2. responding to queries for specific items of information,
3. compiling summary reports, and
4. manipulating quantitative data.

The system performance measures which are employed to evaluate information processing efficiency consider system responsiveness in transporting messages, and the preservation of information quality, i.e., its timeliness, accuracy and completeness.

The measurement of certain aspects of information quality within an automated information processing system requires that the trans-

mitted data items be considered in terms of their interrelationships. Since ambiguous information is of no tactical usefulness, the transmitted data items are scored in terms of "information clusters." These are associated data items which, together, yield a complete description of one aspect of an event. In addition, data items which modify the meaning of the information clusters are also scored. The combination of associated data items and modifying data items contribute to the information quality measure of completeness.

2D. HUMAN FACTORS RESEARCH IN TACTICAL COMMAND SYSTEMS

Seymour Ringel
U.S. Army Behavioral Science
Research Laboratory
Washington, D.C. 20315

BACKGROUND

Technological advancements have led to increased speed, mobility, and destructive power of military operations. To permit commanders to make tactical decisions consistent with rapid and serious changes of events, it is essential that information on military operations be processed and used more effectively than ever before. To meet this need the U. S. Army is developing automated tactical operations systems (TOS) fc receipt, processing, storage, retrieval, and display of different types and vasts amounts of military data. There is a critical need for human factors information in order to maximize combat effectiveness of such systems. The present paper describes the organization and progress of part of a research program to provide that information for command-control systems.

The first step in the program was a survey and analysis of command-control systems and future plans in this area. Basic human factors problems were identified in several critical functions (Figure 1). A Command Systems Laboratory was developed to facilitate research and to permit simulation of various command-control functions. Through the use of random access retrieval-display devices and other equipment, a large number and variety of empirical studies were made possible. This paper will focus on studies of information assimilation and decision making.

Studies are being conducted utilizing both alpha-numeric (charts, totes) and graphic-symbolic (maps, overlays) forms of information. These studies are concerned with the effects on performance of such information factors as amount, density, format, levels of specificity, alpha-numeric versus symbolic representation, rate and degree of updating, hard copy and coding for conspicuity of change, different sensory and display modalities,

individual and group work methods, and finally computer aids through man-computer generated probability data, decision alternatives, and consequences. Performance measures consist of one or more of accuracy, quality, time, and certitude, with respect to information extraction, assimilation, and decision making. The following is a summary of the results and implications of several studies that have been conducted.

CODING INFORMATION IN INDIVIDUAL AND GROUP DISPLAYS (6)

In proposed automated command information processing systems, information will be continually updated and available for display. Perception of change and the speed with which updated information is apprehended can be important factors in command decision making, particularly when large numbers of displays must be scanned. In this experiment, the time taken to locate updated alpha-numeric elements of information was studies as a function of uncoded and coded updated elements (Figures 2, 3), group and individual displays, total amount of elements presented (36, 54, 72, 90), and number of updated elements (4, 8, 12, 16).

Each subject was given a booklet of status charts arranged in the same order of presentation as the updated charts. The charts in the booklet differed from the updated charts in two respects: (a) no elements were coded and (b) the cells corresponding to those in which updated information appeared in the updated charts contained different information. The subject's task was to compare the earlier status charts with the updated charts and cross out those elements in his booklet which differed. The time between presentation of the information and the subject's response, and error scores were obtained for each chart.

The mean time required to locate coded updates was approximately 1/3 of the mean time required to locate uncoded updates (Figure 4). It can also be seen that while time taken to locate updated elements of information increased as a function of increasing total amount of elements presented, the rate of time increase for coded elements was substantially lower than for uncoded elements. For individual and group displays, location times for coded information were essentially equal, but mean time to locate uncoded updates was approximately 15% shorter with individual than with group displays. Finally, coded updates resulted in a reduction of errors by approximately 50%. These results lend support to the incorporation and use of coding capabilities in current and proposed systems. Further, some doubts are raised concerning the relative merits of group displays, at least for certain kinds of tasks.

CONSPICUITY CODING OF UPDATED SYMBOLIC INFORMATION (14)

This study was concerned with the degree to which extraction and assimilation of information is affected by amount of information presented, type and extent of change introduced in updating, and extent to which performance can be improved through various enhancement techniques such as coding updates for conspicuity or providing hard copy history--that is, showing the situation before updating--for comparison with updated slides. If the extent of improvement to be attained by such techniques is known, the value of such improvement can be balanced against the

cost of providing such aids.

Subjects were presented pairs of slides. The first slide of a pair contained either 12, 18, or 24 military symbols positioned on a map background (Figure 5). The second slide of the pair was identical to the first except that 2, 4, or 6 symbols were either removed, added, or repositioned (Figure 6). Three levels of enhancement to make the updated changes conspicious were achieved by three different techniques; hard copy of previous slide to compare with uncoded updated slide, single-cue coding (Figure 7), and double-cue coding. These were contrasted with a condition of no enhancement. While viewing the second slide, subjects engaged in information extraction (counting and identifying). After the second slide was removed, subjects were given an information assimilation task in which they indicated on a scaled-down replice of the first slide the changes they had noted on the second slide.

It was found that in general increasing either the amount of information or the amount of updating resulted in degraded extraction and assimilation performance. In the assimilation task, however, double-cue coding completely nullified the degrading effect of increased amount of information (Figure 8). Extraction was improved approximately 95% by double-cue coding, 70% by single-cue coding, and not at all by hard copy history (Figure 9). Assimilation was improved approximately 55% by double-cue coding, 45% by single-cue coding, and 30% by hard copy (Figure 10). In a related study it was also found that as extent of updates increased, accuracy remained relatively unchanged but confidence in performance decreased (Figure 11). These findings again confirm the desirability of incorporating and using relatively simple coding capabilities in current and future systems. In addition, findings regarding confidence in performance suggest that one should not focus on accuracy or quality of performance to the exclusion of confidence, itself a basic ingredient in the decision process.

CONFIDENCE AND POSTERIOR PROBABILITIES IN A DECISION TASK (2)

Confidence measures have been obtained in conjunction with information extraction and assimilation tasks in several studies. Typically, expressed confidence has not been a good indicator of the extraction or assimilation performance upon which it was presumably based. On the basis of everyday observation and introspection, confidence would be expected to play a salient role in decision making. Thus, the discrepancy mentioned above could adversely affect decision behavior. It was the purpose of the present experiment to investigate the role of confidence as it relates to realty and decision making in the Bayesian context of subjective probability for an interpretive decision task.

In this task, a sequence of nine slides depicts an enemy buildup of forces. Each slide within a sequence represents an independent sighting of equipment and contains varying combinations of three types of equipment totaling six per slide. The proportions among the three types of equipment provide the only clues as to which of three possible types of regiments is being built up. The subject's task is to indicate after each slide what type of unit is being built up, to estimate

the probability that it is in fact that particular unit, and to commit himself to action when he is reasonably convinced that he has enough information for a decision. The sequences are designed so that the true probabilities associated with the unit that is building up increase from slide to slide. There is a cost associated with each increment of information (slide), and payoff is given only if the "action" taken is correct. The major variables of interest are two rates of probability increment, two cost-of-information schedules, two work methods (probability estimates for single most likely units vs requiring subjects to consider all information and make estimates for all three possible units), and finally, presenting the sighting reports to the subjects without (Figure 12) and with (Figure 13) computer furnished cumulative proportion information concerning the enemy equipment. Time to decision (number of slides), accuracy of decision, and confidence estimates (subjective probability) are the measures to be analyzed.

The results gleaned from the data at this point in time indicate that all aspects of performance improved when subjects were required to consider all the information and provide probability estimates for all three possible enemy units. Similar improvements in performance resulted from the introduction of a simple computer aid in the form of cumulative proportions of enemy equipment, thereby relieving the subjects of clerical work and errors and permitting them to concentrate on the heart of the problem. These results point up the utility of introducing and training personnel in empirically determined work methods. Further, they demonstrate the value of using the computational capability of computers to assist humans in problem solving rather than delimiting the computers use to a display driving device.

DECISION MAKING WITH GRAPHIC AND ALPHA-NUMERIC INFORMATION (15)

In future automated command and control systems, information may be generated and displayed in graphic form (flag symbol overlays on map backgrounds) and in alpha-numeric form (tables and totes). Since there is a choice of viewing information in alpha-numeric or graphic form, and even more important, a choice of including both capabilities in future systems, information about the relative effects of both forms of information presentation on decision accuracy and timeliness is needed.

Subjects were presented series of slides depicting three enemy sectors. The same information was presented graphically (Figure 14) in one condition and alpha-numerically (Figure 15) in another condition and at two different updating rates within each condition. With successive slides, the enemy forces in one of the sectors were forming for attack at a faster rate and with more appropriate disposition of forces than the forces in the other two sectors. After each slide, the subject was asked to make a decision as to which of the enemy forces showed the greatest potential for attack and to indicate how confident he was about the decision.

Results indicate that subjects were willing to render "final decisions" of equal quality and with equal confidence at about the same

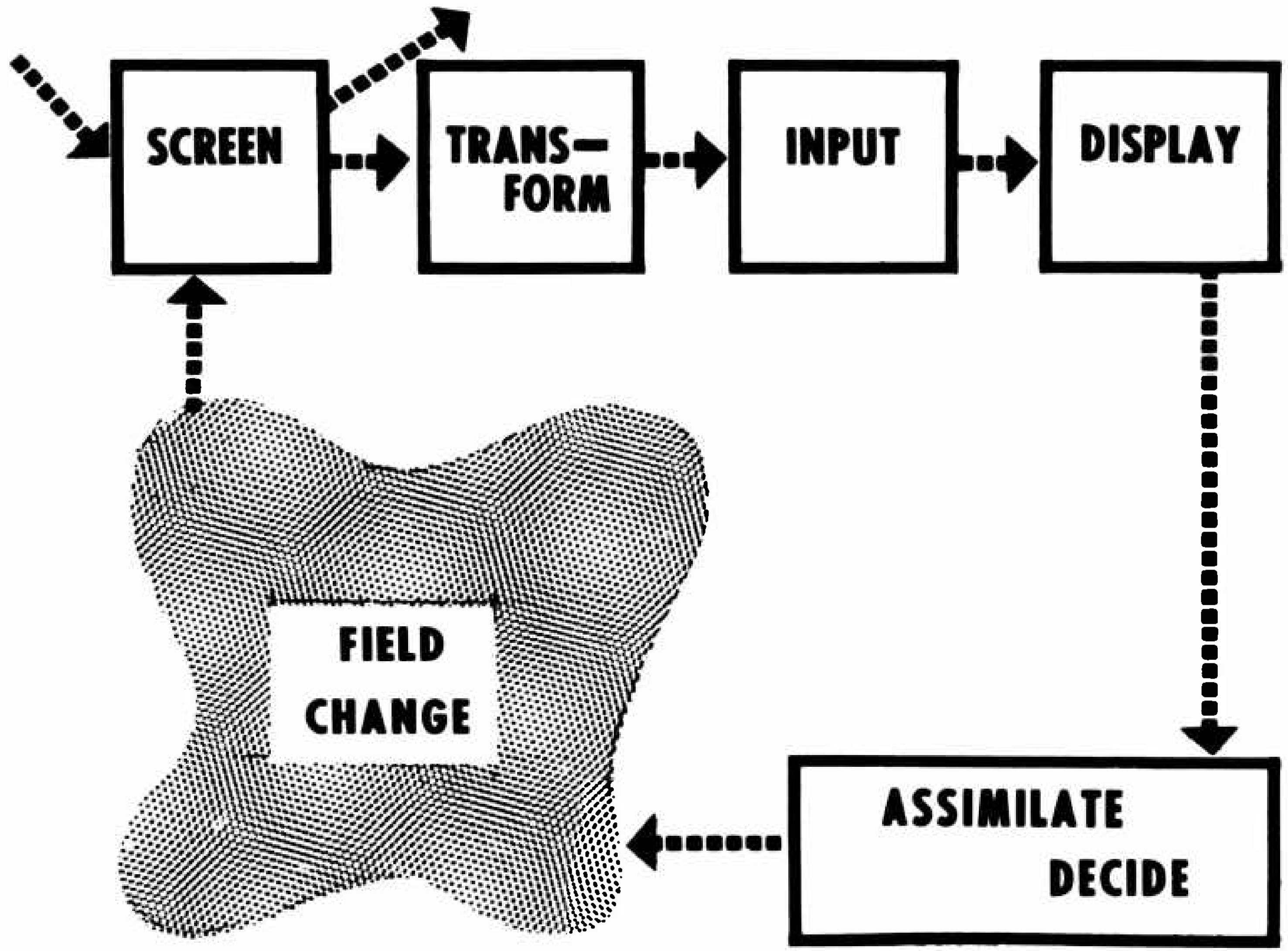


Figure 1. Schematic representation of operations and information flow in automated TOC

FRIENDLY TACTICAL UNITS STATUS					
UNIT	ACTIVITY	EFF STRENGTH	TERRAIN	ARMOR STATUS	WEATHER
23	SUPPLYING	77	FARMLAND	92	DAMP
72	REBUILDING	96	LOWLAND	85	SLEET
57	ASSEMBLING	87	RIVERS	91	SNOW
82	WITHDRAWING	81	MEADOWLAND	77	HUMID
34	FLANKING	80	MARSHLAND	76	RAIN
13	SUPPORTING	70	DESERT	96	HURRICANE
45	SURROUNDING	85	MUDDY	95	SUNNY
99	SCREENING	90	SWAMP	87	WINDY
64	REGROUPING	78	ROCKY	83	HAIL
24	PLANNING	83	LAKES	89	DRY
28	TRAINING	79	VALLEY	80	FREEZING
56	HOLDING	75	PLATEAU	78	COOL
18	PENETRATING	72	FOREST	70	HOT
53	ADVANCING	94	HILLS	90	FOG
31	DEFENDING	95	MOUNTAINS	94	CLEAR

FIGURE 2. EXAMPLE OF UNCODED UPDATED ALPHA-NUMERIC INFORMATION

FRIENDLY TACTICAL UNITS STATUS					
UNIT	ACTIVITY	EFF STRENGTH	TERRAIN	ARMOR STATUS	WEATHER
23	LANDING	77	FARMLAND	92	DAMP
72	REBUILDING	96	LOWLAND	85	OVERCAST
57	ASSEMBLING	87	RIVERS	91	SNOW
82	WITHDRAWING	76	MEADOWLAND	82	HUMID
34	FLANKING	80	MARSHLAND	76	RAIN
13	SUPPORTING	71	DESERT	96	HURRICANE
26	SURROUNDING	85	FLATLAND	86	SUNNY
99	SCREENING	90	SWAMP	87	WINDY
64	REGROUPING	78	JUNGLE	83	HAIL
41	PLANNING	83	LAKES	89	DRY
28	TRAINING	79	VALLEY	80	FREEZING
37	HOLDING	75	CLIFFS	78	STORM
18	PENETRATING	72	FOREST	75	HOT
53	ASSAULTING	94	HILLS	90	FOG
31	DEFENDING	78	MOUNTAINS	94	CLEAR

FIGURE 3. EXAMPLE OF CODED UPDATED ALPHA-NUMERIC INFORMATION

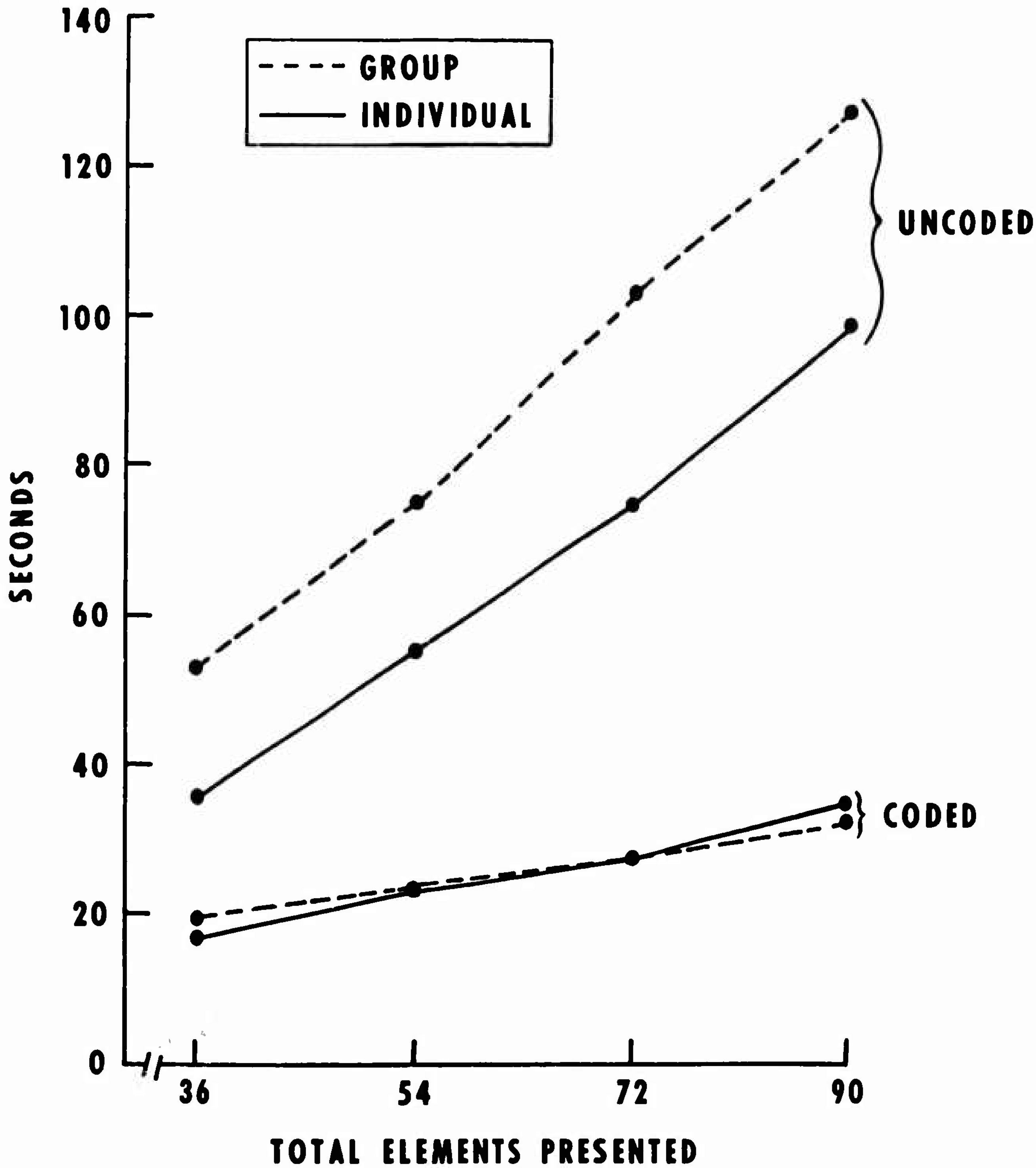


FIGURE 4. MEAN TIME FOR CODED AND UNCODED CHARTS AT EACH LEVEL OF TOTAL ELEMENTS PRESENTED

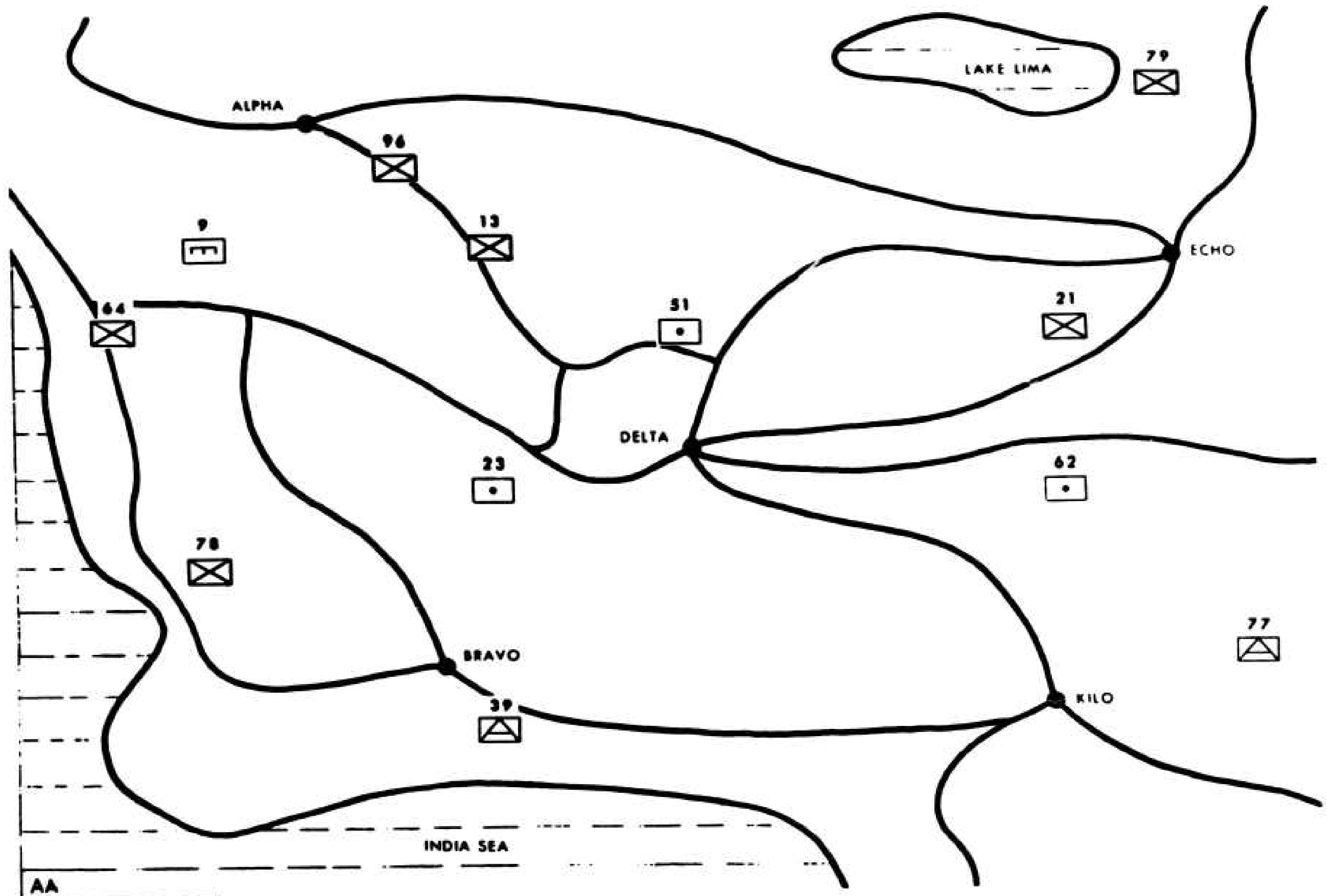


FIGURE 5. BASIC SLIDE WITH 12 UNITS

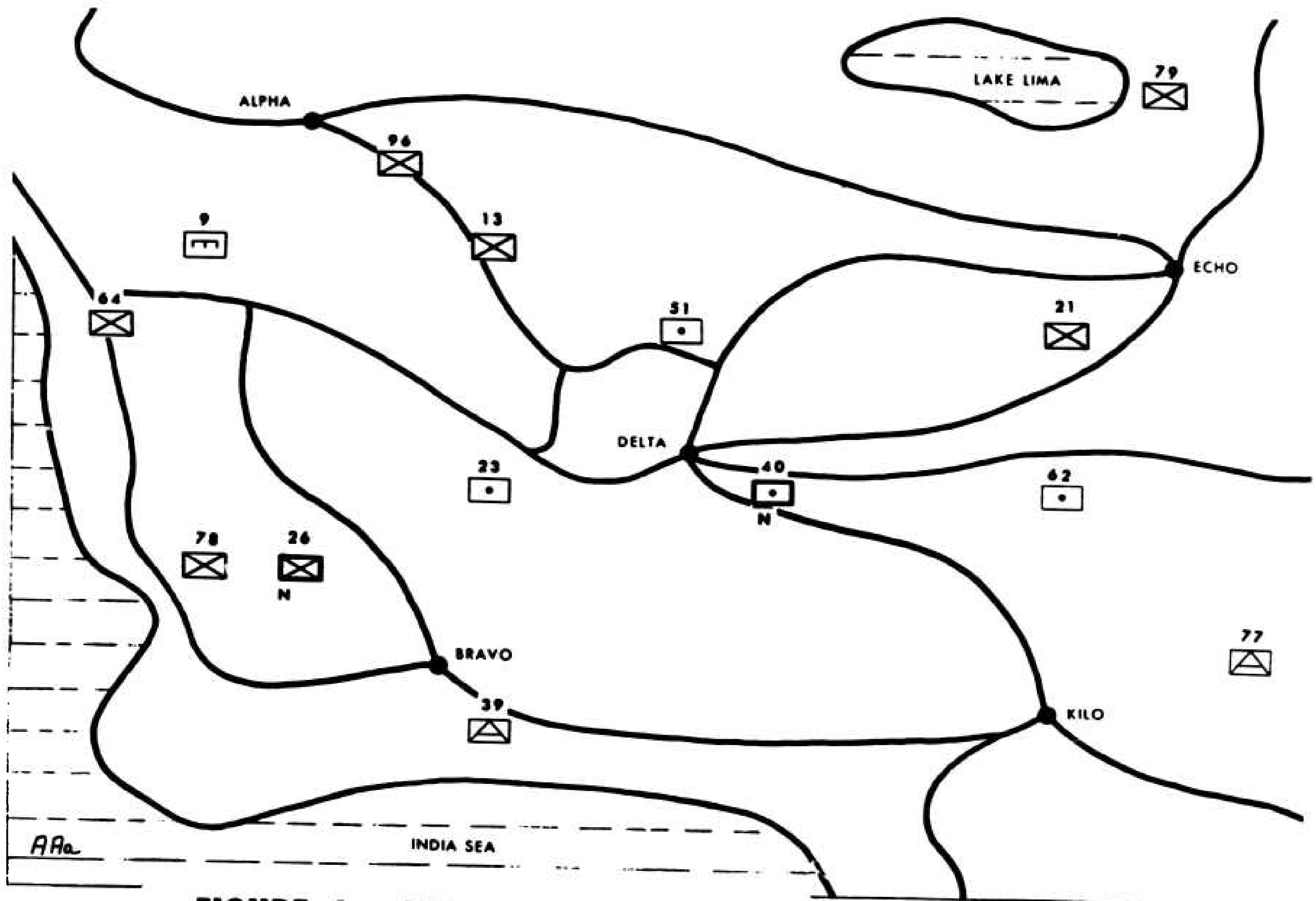


FIGURE 6. UPDATED SLIDE WITH 2 "ADDED" UNITS

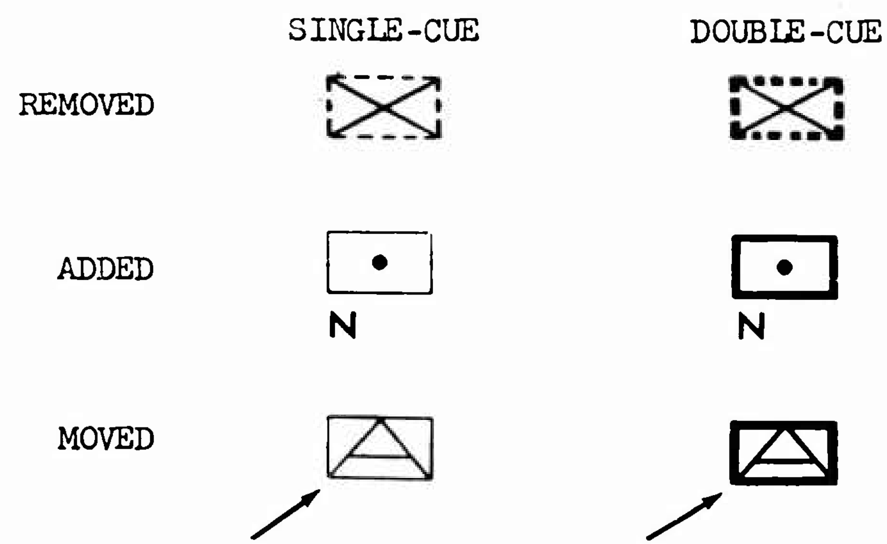


FIGURE 7. EXAMPLES OF SINGLE-CUE AND DOUBLE-CUE CODING

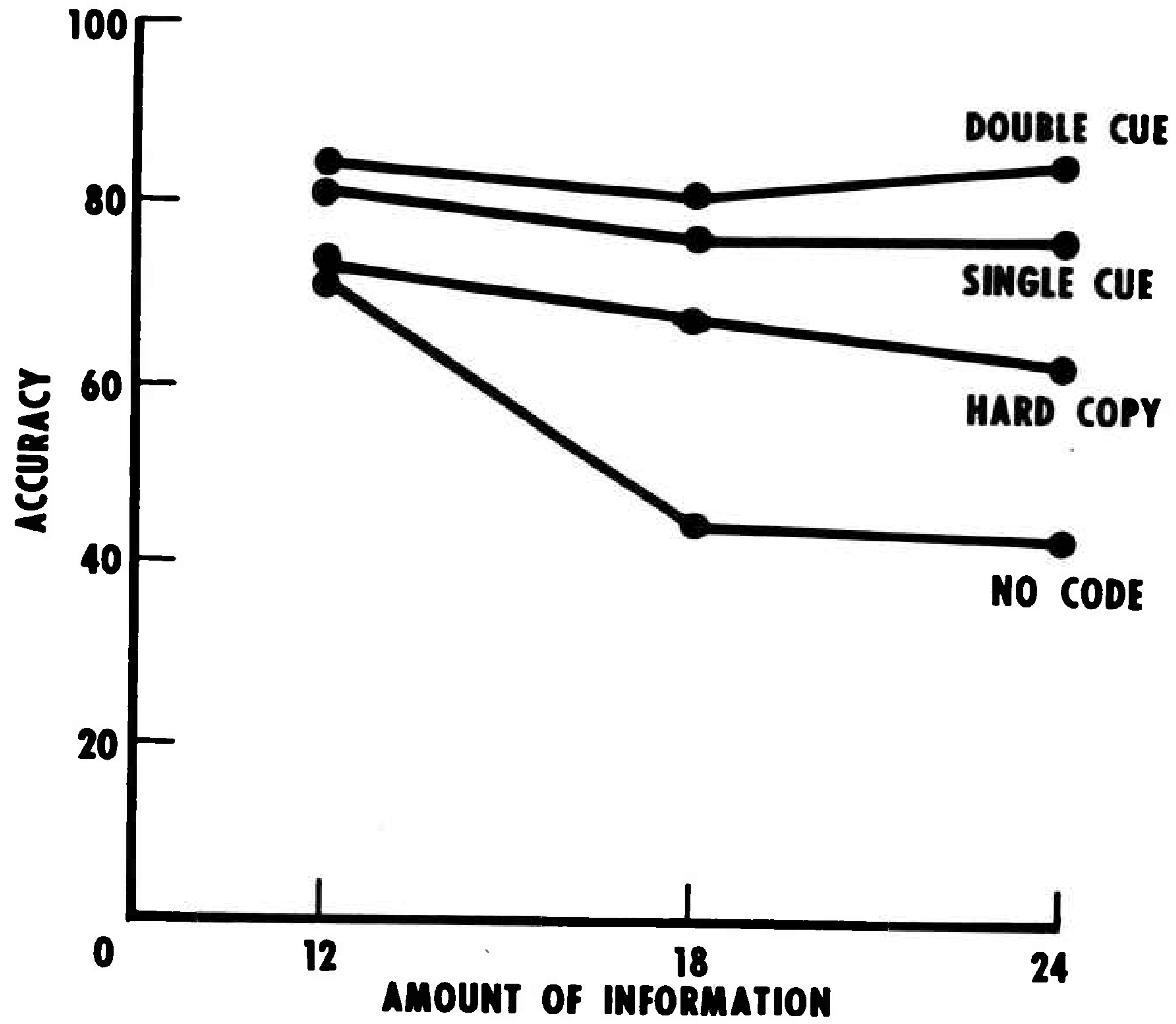


FIGURE 8. MEAN ACCURACY AT EACH AMOUNT BY ENHANCEMENT

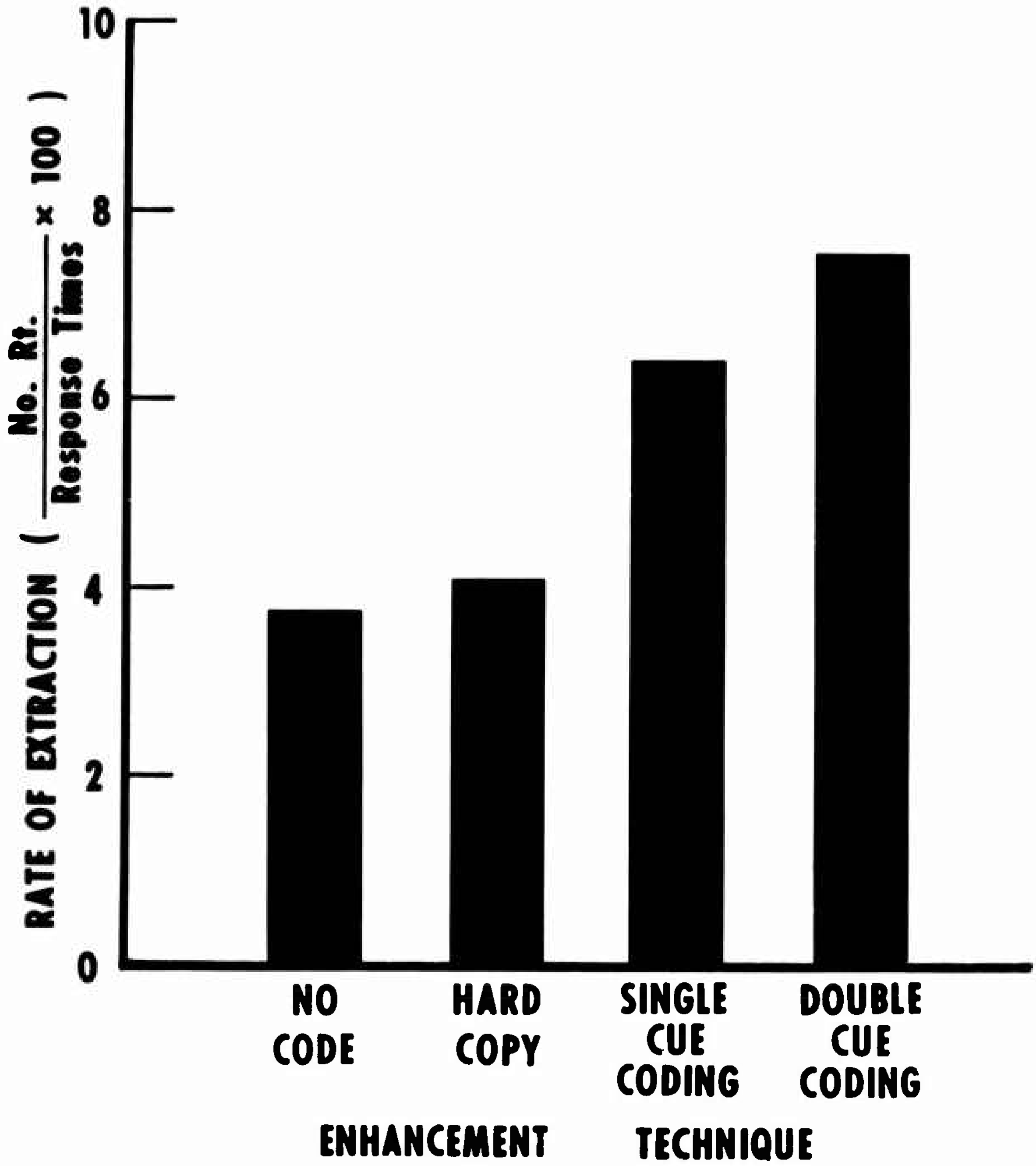


FIGURE 9. EXTRACTION PERFORMANCE BY ENHANCEMENT TECHNIQUE

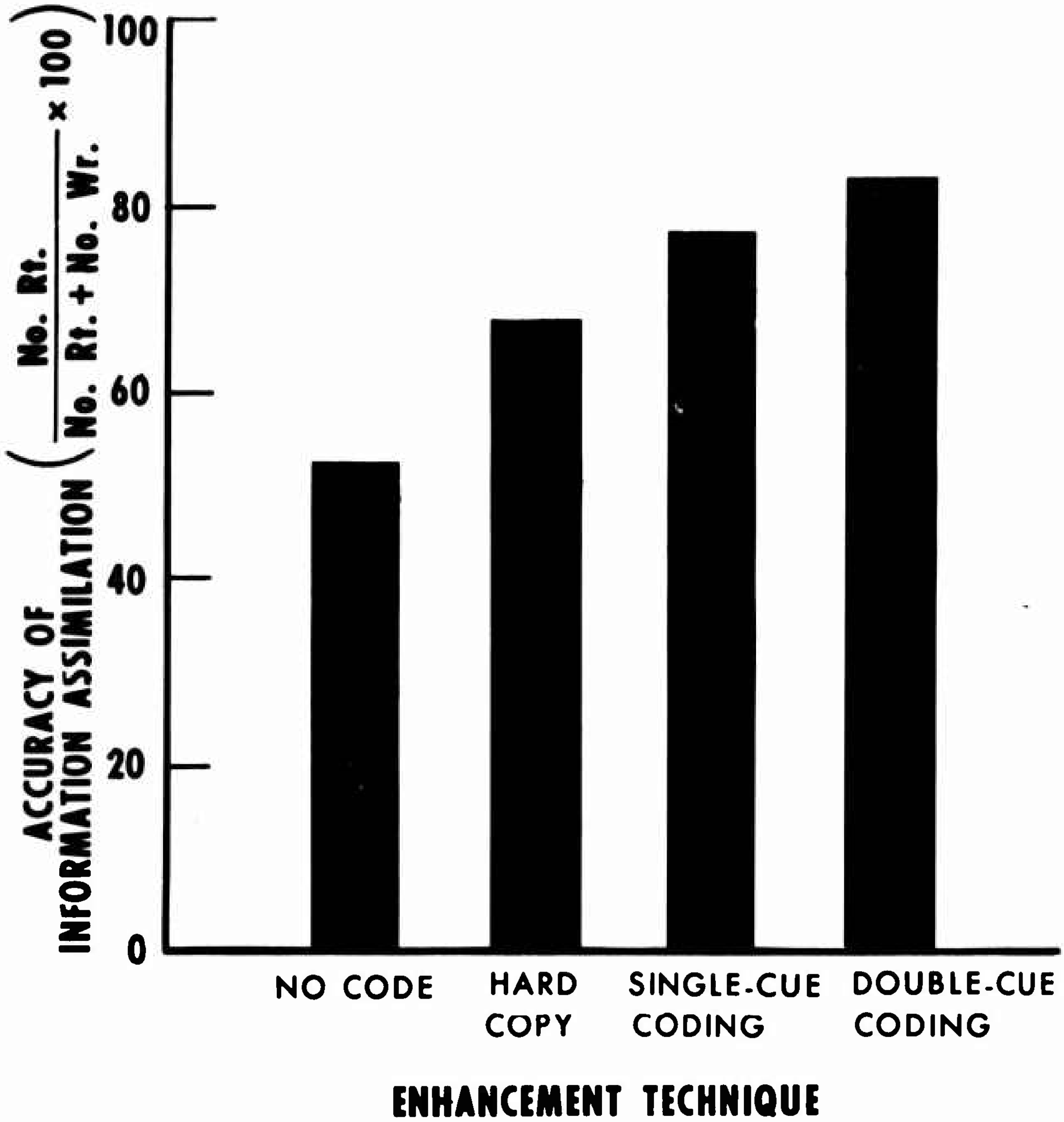


FIGURE 10. ASSIMILATION PERFORMANCE BY ENHANCEMENT TECHNIQUE

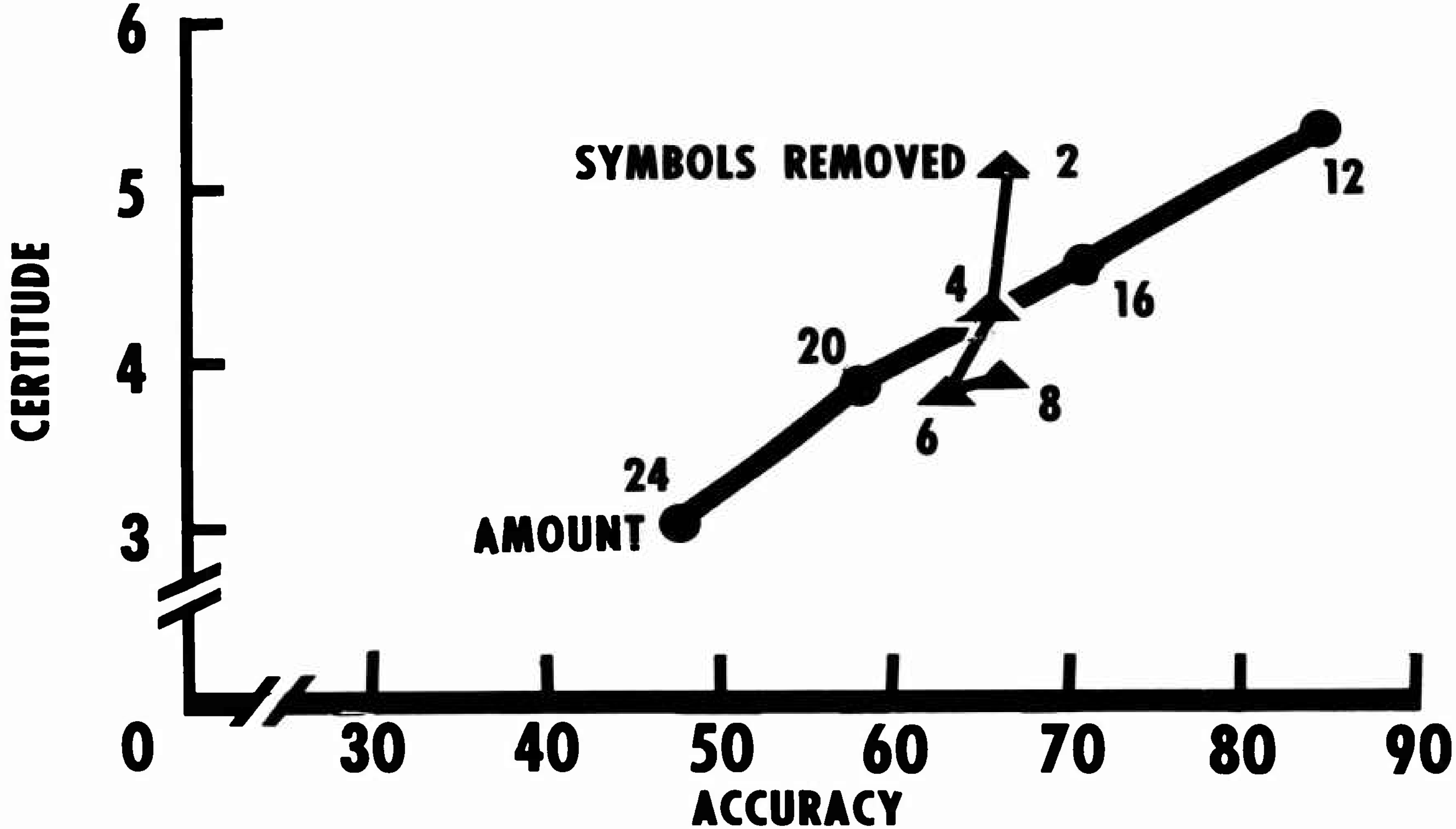


FIGURE 11. RELATION OF CERTITUDE TO ACCURACY

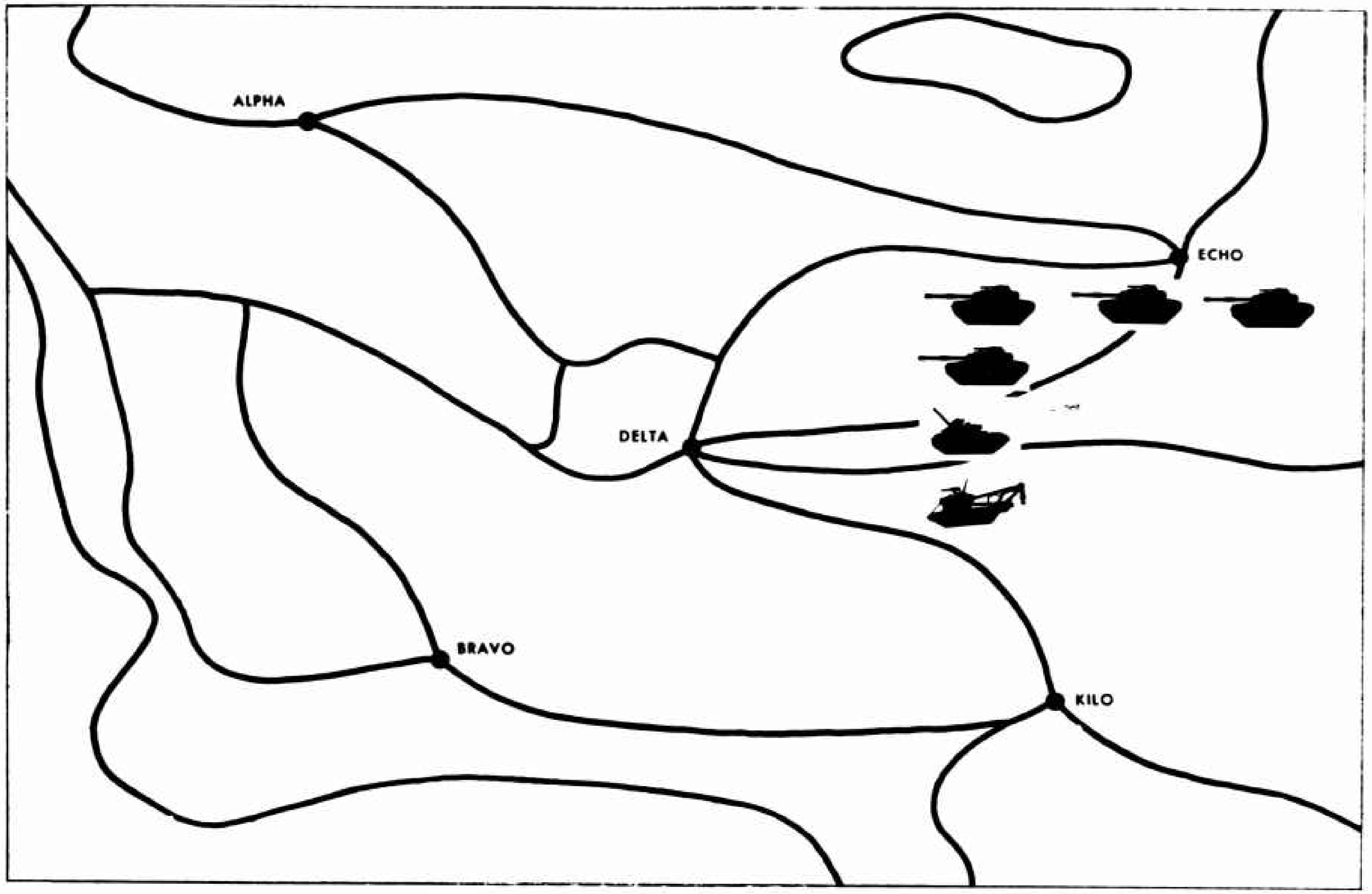


FIGURE 12. EXAMPLE OF EQUIPMENT SIGHTING

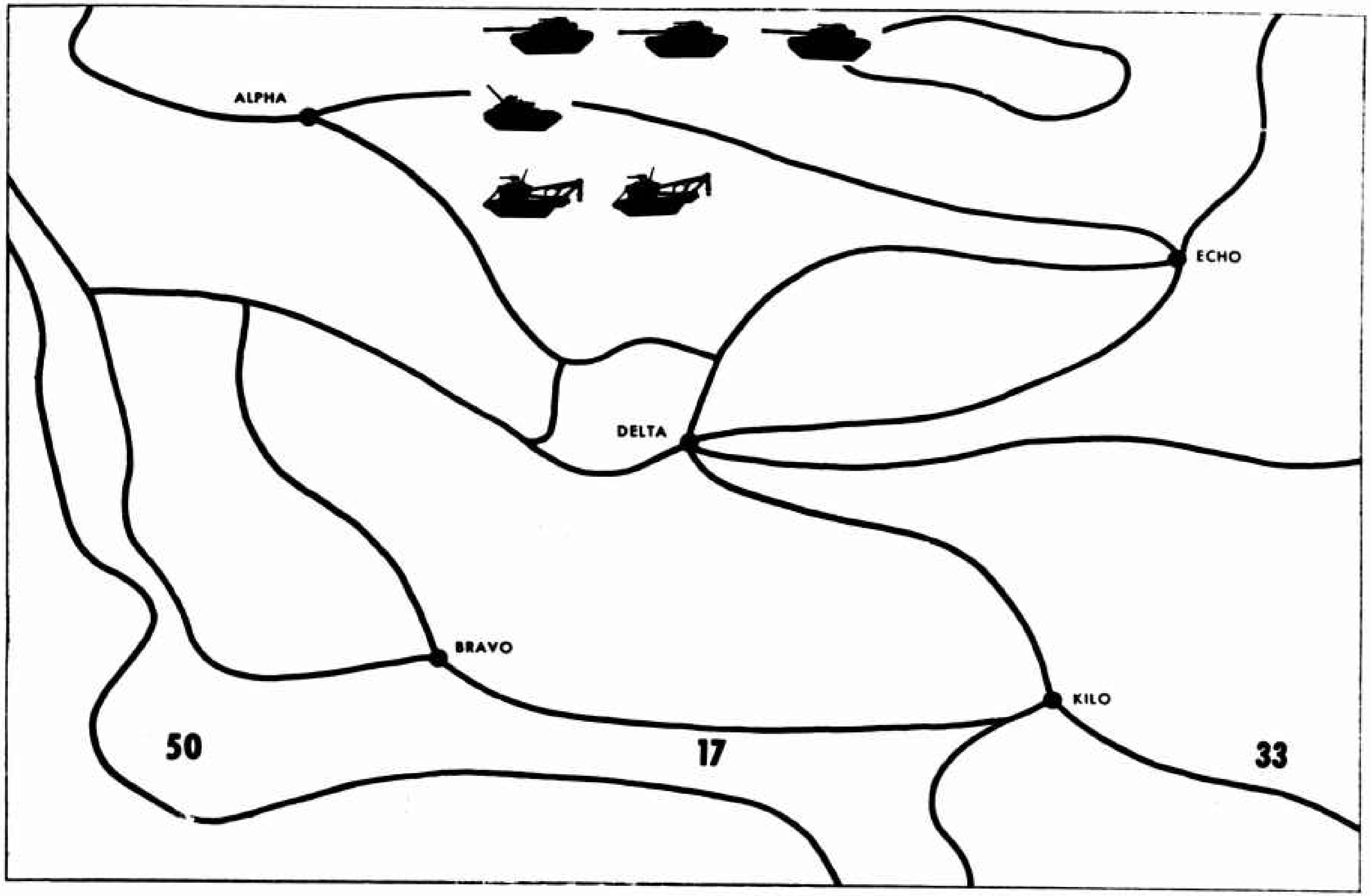


FIGURE 13. EXAMPLE OF EQUIPMENT SIGHTING WITH PROPORTIONS

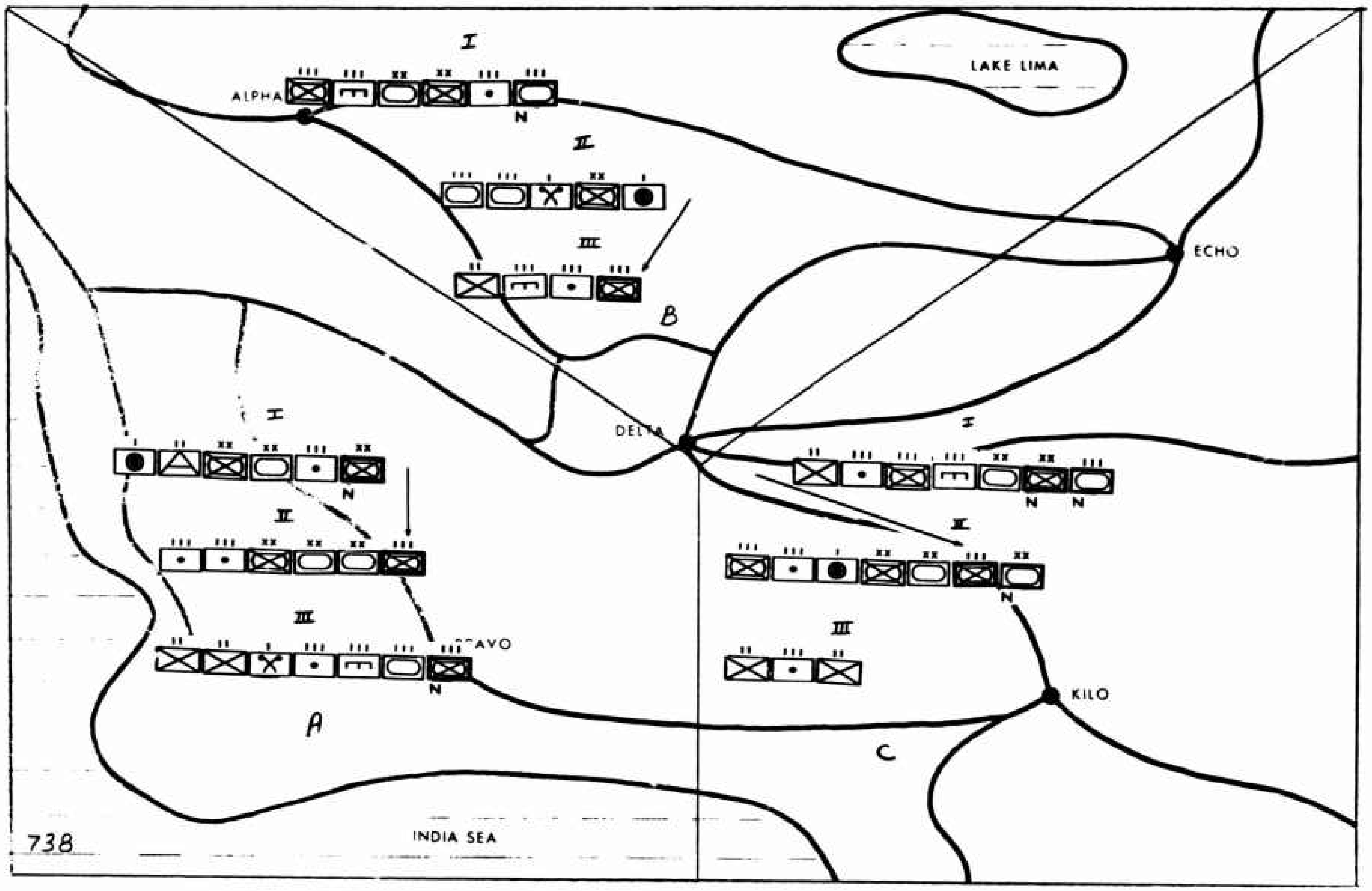


FIGURE 14. SITUATION DEPICTED IN SYMBOLIC FORM

ENEMY UNIT STATUS					
SEC. A	UNIT	SEC. B	UNIT	SEC. C	UNIT
I	TRANS CO A D BN MTR RIF DIV TANK DIV ART RGT MTR RIF DIV (ADDED)	I	MTR RIF RGT ENG RGT TANK DIV MTR RIF DIV ART RGT TANK RGT (ADDED)	I	INF BN ART RGT MTR RIF RGT ENG RGT TANK DIV MTR RIF DIV (ADDED) TANK RGT (ADDED)
II	ART RGT ART RGT MTR RIF DIV TANK DIV TANK DIV MTR RIF RGT (MOVED FROM I)	II	TANK RGT TANK RGT CHEM CO MTR RIF DIV TRANS CO	II	MTR RIF RGT ART RGT TRANS CO MTR RIF DIV TANK DIV MTR RIF RGT (MOVED FROM I) TANK DIV (ADDED)
III	INF BN INF BN CHEM CO ART RGT ENG RGT TANK RGT MTR RIF RGT (ADDED)	III	INF BN ENG RGT ART RGT MTR RIF RGT (MOVED FROM II)	III	INF BN ART RGT INF BN

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FIGURE 15. SITUATION DEPICTED IN ALPHA-NUMERIC FORM

point in the development of a situation (enemy preparing for attack) whether the information is depicted in alpha-numeric (charts) or graphic (units deployed) form. This introduces some questions concerning the relative utility of elaborate automated symbol generation and display devices at all echelons in the field as against manual plotting of graphic information when such information is deemed necessary.

CONCLUSION

The studies reported represent a sampling of the work accomplished thus far. Other studies have been conducted and are being planned in the areas indicated at the beginning of this paper. Carried to conclusion, it is hoped that the program will enable users, designers, and developers to anticipate and avoid many pitfalls in future generations of command-control systems.

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2E. VARIABLES OF INTEREST IN DISPLAY SYSTEM RESEARCH AND DESIGN

Joel N. Bloom, Carl A. Silver
and Mrs. Adele Farber
The Franklin Institute Research Laboratories
Philadelphia, Pennsylvania 19103

INTRODUCTION

Displays and display systems are essentially devices for the communication of information. Whether we consider elaborate and sophisticated systems such as those developed for strategic war-room use, or relatively uncomplicated displays such as schedule bulletin boards at the brigade motor pool, their *function* is the same: to transmit information—optimally, in such a manner that the possibility of misunderstanding or mininterpretation is reduced or even eliminated. Their chief purpose is to promote communications between *people*—between the originators, or *sources*, of information and the recipients, or *users*, of that information. Displays are, in this broad sense, an information linkage between people—a sometimes vital part of the information-transfer process.

Studies of this process have tended to concentrate in two areas, termed here "display-related variables" and communications-process variables".

DISPLAY-RELATED VARIABLES

As you well know, psychologists have been studying the problems of what makes a good display since the early part of World War II. The vast majority of these studies have focused on what may be called human-factors considerations (such as legibility, visibility, use of symbols or alphaneumerics, and display density). Extensive reviews have been published on these studies by Sampson and Wade (1) and by Drs. Silver and Landis of our staff (2), the major themes of which are probably familiar to most of you. These reviews have revealed some gaps in our knowledge and lead directly to a series of studies which we have carried out.

In concentrating on human-engineering considerations, the literature on human factors has ignored a fundamental aspect of the display problem: *how* the decision-maker obtains his information is less important than *what* he does with it. That is, the "goodness" of a display is indexed by how efficiently and wisely he used the information. Considered in this way, most studies which utilize such measures as search time, reading speed, reaction time, and counting are based on an incomplete premise. While it is difficult to evalute the "goodness" of a man's decision, we cannot ignore the problem and thereby accept irrelevant measures which are not so difficult.

One unresolved problem is the use of decision *versus* extractive indices. Another problem derives from the fact that the vast majority of studies have used meaningless displays upon which coding formats are varied. While such displays permit experimental control, it has yet to be demonstrated that rules derived from such formats are valid in the command-and-control situation. I am not suggesting that we ignore the niceties of experimental control; however, when display studies are conducted, some method for relating the experiment to the field situation should be explicitly included.

A final lack in the research stems from the types of subjects used in many of these studies; the application of information produced by studying college sophomores to division commanders is of dubious value. Obviously, college sophomores are more accessible than major generals; nevertheless, relating one to the other cannot be based on blind faith with a few references to the generality of psychological laws.

These three issues, which we have attempted to resolve, seem to us to be most in need of research. The problems that we have encountered, both in the laboratory and the field, have been large, but hopefully tractible.

COMMUNICATIONS-RELATED VARIABLES: THE PEOPLE DIMENSION

Having briefly mentioned some of the major "human factors"-type advances which have been made in the field of display systems, I would like now to turn to another, more subtle aspect of the problem — one in which only limited progress has been made. For lack of a better term, we can label this the "people dimension."

A study, the "Art and Requirements of Command", has recently been completed by the staff of The Franklin Institute Research Laboratories (3). Part of a larger effort directed toward identifying and analyzing the command-control support requirements of senior Army commanders, this study is unique in many respects. It represents a departure from the more traditional "systems" approach to command-control, in which systems are studied and developed from the perspective of the information-systems analyst and presented to the senior commander essentially as an accomplished fact. But the commander in the military establishment — more so than any single figure in a large-scale industrial enterprise — represents the unity of command and control. Accordingly, we focused the study effort on the commander's requirements for communicating and receiving both objective and subjective information; that is, we studied the command process by studying the commander. We undertook to treat command broadly as an exercise in human interaction and interpersonal communications.

We hoped, in this manner, to arrive at meaningful criteria for the design and development of systems which would in fact — as well as in theory — satisfy critical requirements, and ultimately to create a basis for decisions concerning the effectiveness of various system mixes of equipment, organization, and personnel practices and techniques.

We considered this overall problem to be critical and immediate, first, because we were convinced that the wholesale introduction of sophisticated information-processing and communications systems might bypass the needs of the very persons such systems purport to serve — the senior commanders; and second,

because senior military commanders are increasingly seeking more detailed and systematic information about the situation and status of lower command levels. The very nature of conflicts like Vietnam; increased centralization; and the impact of total, rapid, and dramatic coverage of small-unit military operations by the press and mass media all combine to increase information demands. The flow of the required information thus becomes critical.

Approach and Methodology

Our approach to the study was then essentially "behavioral". Our method of investigation was to pursue three separate, but parallel, lines of inquiry. The first line of inquiry, a "generalship" study, involved administering a requirements and techniques-type questionnaire to a large cross section of active and retired senior commanders. The second line of inquiry into the command process was historical; here, we sought to determine patterns of command and control of several past commanders. And the third line of inquiry consisted of a questionnaire-interview program administered to staffs and commanders in the Seventh Army, Europe.

A composite command-process description was developed for each of these parallel efforts; each description was focused on command techniques, requirements, procedures, and mechanisms. These composites were then merged into a comprehensive command portrait, or analytical description. The description was organized to correspond to the four essential stages in the command process:

1. Mission evaluation and interpretation;
2. Issuing of directives;
3. Monitoring of the development, preparation, and issuance of coordinated plans and orders; and
4. Followup and evaluation during operations.

Each command stage was treated in terms of a general framework developed as part of the study effort (see Figure 1).

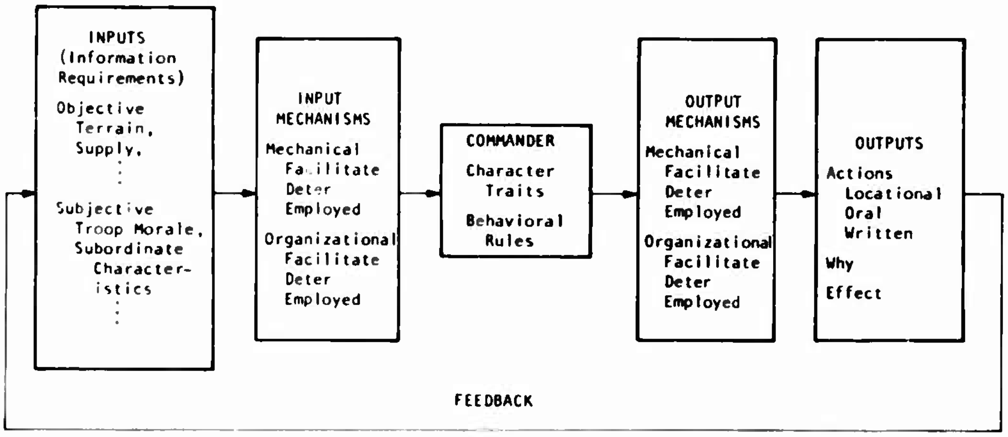

Figure 1. Framework for Description

As seen from this figure, the commander is the focal point in the command process. "Inputs" are categories of information requirements; "input mechanisms" are the mechanical or organizational means used to satisfy these requirements. "Outputs" consist, in effect, of the possible forms of what the commander does: oral, written, or locational (that is, actual movement from or to a given location); again, the "output mechanisms" are those organizational or mechanical tools employed to produce the various outputs.

The input or output mechnisms employed can either facilitate or deter; the desired goal, of course, is to assure that mechanisms facilitate rather than deter. Certain mechanisms are merely indicated as "employed", implying that it has not yet been determined whether these facilitate or deter.

By applying this framework to each command stage, attention could be focused on critical factors. Because each stage was described in the same terms, the requirements and mechanisms of the different stages could meaningfully be compared. It became evident that both requirements and the means for their satisfaction varied with the four stages in the command process. For example, although the commander's information requirements for stages 1 and 4 (mission evaluation and followup during operations) are roughly comparable, the time factor is more critical during the follow-up period and the pressures of on-going operations transform the conference/consultations mechanisms employed in stage 1 into repeated personal visits during followup.

Command-Process Postulates

The four-stage description of the command process revealed several significant "postulates":

Personal contact is essential. Command is primarily a "people process" rather than a formal system. Historical research revealed that past commanders considered face-to-face personal contact with their subordinate commanders and with their staffs to be an essential part of the command process. On the basis of both questionnaires and interviews, it became evident that present-day commanders (Korea through Vietnam) continue to view such personal contact as critical. Communications technology has certainly improved in recent years, and Vietnam commanders, for example, are increasingly using radio, telephone, and other command communications devices; but despite improvements, and despite increased use, they continue to consider personal contact to be vital.

The commander requires both objective and subjective information. The research conducted into both past and present techniques of command revealed that the commander's information requirements range from such objective statistics as numbers of unit casualties, to such subjective factors as troop morale. Although a commander's requirements for information will obviously reflect the specific situation and cannot, therefore, be generally specified, various categories of requirements can be identified.

Information must flow both to and from the commander. The commander must be informed and must inform; he must "sense" and convey attitudes and moods.

Mechanical communications and information systems supplement human mechanisms for gathering and disseminating information, but cannot replace them. Massive effort and

funds have been expended to develop automatic-data-processing (ADP) systems during the past decade. Such systems can supplement human mechanisms, but obviously cannot perform many of the functions critical to the information-flow problem. With the present state-of-the-art of ADP, these systems cannot solve tactical problems, make command decisions, or process subjective or even quasisubjective data. ADP systems can, however, provide command data banks to serve as commander and staff tools.

The type and level of detail of required information vary. The once-popular notion that the higher an individual is in a hierarchy of management or command, the less detail he requires, has been negated by the recent tendency towards increased centralization. High-level commanders in Vietnam, for example, are increasingly concerning themselves with the operational details of relatively small units; it is not unusual for a theatre commander to seek information regarding battalion activities or to attempt to convey information — generally subjective — to a battalion commander. Press and mass-media coverage of Vietnam military operations further prompt senior commanders to seek details of relatively small-unit activities.

The organization of required information varies primarily with the commander, and with the situation. For example, division commander X may view logistics as the key factor, while division commander Y may consider morale to be overriding. Differences in perspective, personality, preferences, and techniques will clearly affect the types of information each seeks and, consequently, the way in which that information will have to be organized.

Command as Information-Transfer Process

These postulates suggested to us that command could be viewed as an information-transfer process in which required objective and subjective information is transferred or communicated to and from the commander. Figure 2 is a representation of the information-flow system in its simplest form.

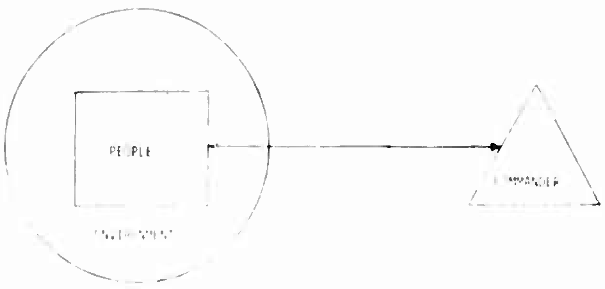

Figure 2. Basic Information-Flow System

From subordinate units the commander receives information about them and their environment; he also transmits information to them. Ideally, information flows directly to and from the commander. In such a case, the commander would be present at the site of the action. However, in practice, because the commander commands many units which are generally scattered over a fairly extensive area, his constant physical present is impossible. Accordingly, this diagram is expanded (Figure 3) to reflect the persons and mechanisms through which information must flow.

As shown in Figure 3, an "other person" (generally the subordinate unit commander) and a technological communication system (radio net, telephone, or teletype) are interposed between the unit and the commander. The commander now "sees" the unit and its environment,

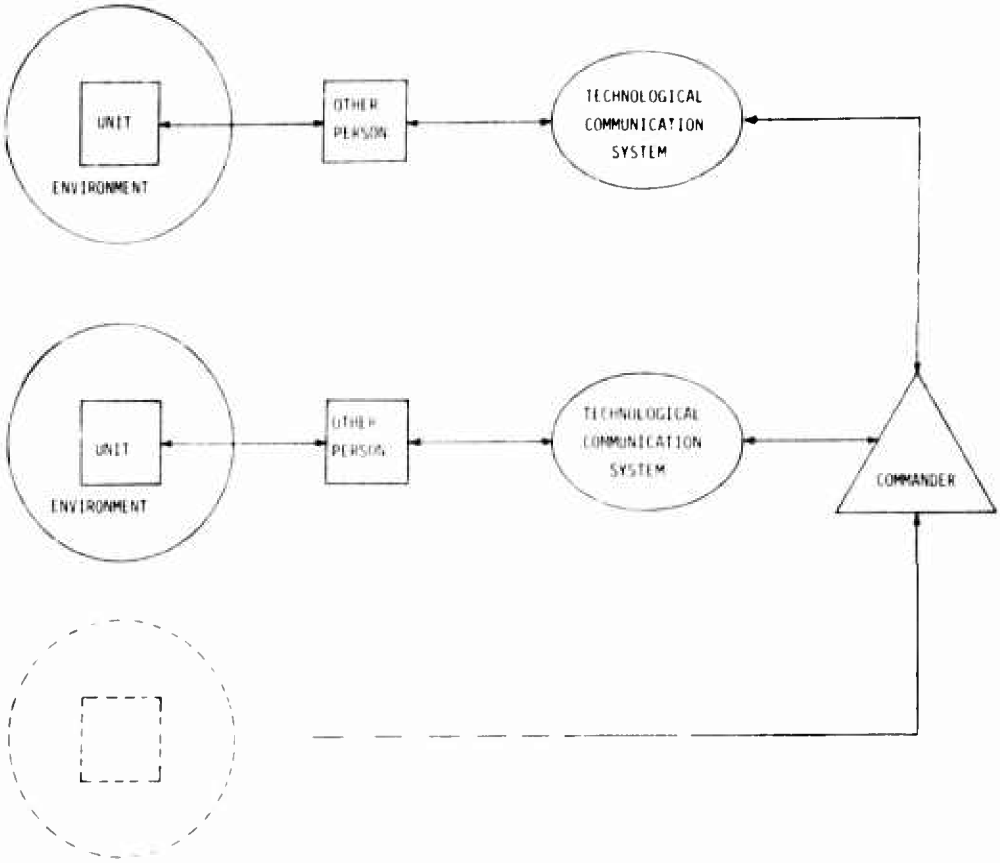

Figure 3. Partially Expanded Diagram of Basic Information-Flow System

and "is seen" by the unit, indirectly. Direct contact (physical presence) is limited; the commander selectively visits units under his command but cannot remain with one unit at all times.

This overall system can be termed the Command-Control Support System (CCSS). Since the CCSS must transmit subjective information in such a manner as would substitute for the commander's physical presence, three measures of effectiveness can be suggested: delay, error, and loading.

The usefulness of two of these measures has already been demonstrated in connection with technological communication systems (4) which transmit concrete, defined messages:

$$\text{delay} = \text{time}_{\text{out}} - \text{time}_{\text{in}}$$

and

$$\text{error} = \text{message}_{\text{out}} - \text{message}_{\text{in}}$$

For information flowing *to* the commander in the CCSS, these measures are defined as:

$$\text{delay} = \text{time}_{\substack{\text{receipt by}\\ \text{commander}}} - \text{time}_{\text{happening}}$$

and

$$\text{error} = \text{information}_{\substack{\text{as commander}\\ \text{would have}\\ \text{seen}}} - \text{information}_{\substack{\text{received}\\ \text{by com-}\\ \text{mander}}}$$

This definition implies that the subjective information, which constitutes the core of the problem, cannot be measured objectively, but

only in terms of what the commander would have seen had he been there.

For information flowing *from* the commander,

$$\text{delay} = \text{time}_{\substack{\text{receipt}\\\text{by unit}}} - \text{time}_{\substack{\text{transmitted}\\\text{by commander}}}$$

and

$$\text{error} = \text{information}_{\substack{\text{transmitted}\\\text{by commander}}} - \text{information}_{\substack{\text{received}\\\text{by unit}}}$$

The third measure, loading, is imposed by the limits to the amount of information any single individual can effectively receive, make decisions on, or transmit:

$$\text{loading} = \frac{\text{commander load}}{\text{commander capacity}}$$

Mode of organization and level of required detail of information also affect loading.

In the ideal CCSS, delay and error would be reduced to zero; and information would be transmitted to and from the commander in such a way as to effectively substitute for his actual physical presense. In this ideal case, the information load equals the commander's capacity for absorbing and using that information.

Information "Filters"

Such extraordinary improvements have been made in the technological communications system in recent years that a prediction of zero delay and zero error for this portion of the CCSS is possible. Reductions in delay and error in the technological system result initially in comparable delay and error reduction for the overal system. However, the improvement in reliability and speed has encouraged much more frequent use of such technological devices; and, combined with the generally increasing information demands and requirements of senior commanders, the net result is to overload the commander considerably. The changes introduced into the system as a result of this overload are shown in Figure 4, which is a further expansion of the basic CCSS.

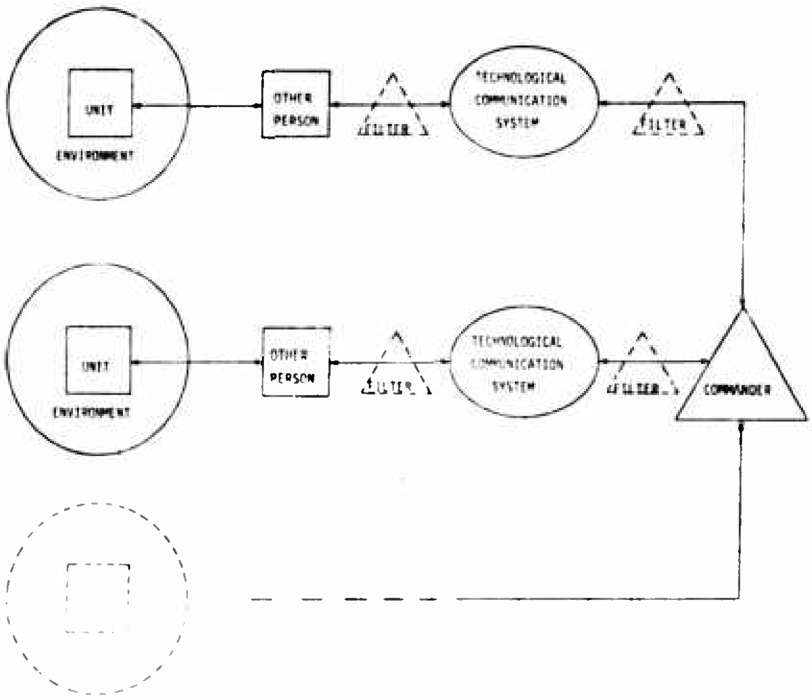

Figure 4. Fully Expanded Diagram of Information-Flow System

As shown in Figure 4, "filters" have been introduced into the system to rank information according to its relevance. The purpose of such relevance determination is to ensure that only that information which the commander requires at any given time is transmitted to him; the load on the commander is thus reduced.

The number and location of these filters in the system is not limited or fixed. Filters at the right, or headquarters, end of the diagram may be large staff organizations; filters at the left, or unit, end may simply be the "other person" (often the unit commander) armed with a set of instructions regarding both what to report and when.

The results of our study suggest that present human filters are inadequate to the task; in fact, they may actually *increase* delay and error. Despite the considerable progress in technological communication systems, despite the increased use by commanders of radio, telephone, and other technological command mechanisms, commanders tend markedly to return to the simplest form of the system. All study data suggest that the time spent by senior commanders in establishing personal and direct contact with subordinate commands has not diminished appreciably from World War II to Vietnam.

This practice has apparently worked well in Vietnam. However, there are several very sound reasons for concluding that the substitution of personal presence for an inadequate CCSS is not the most effective permanent solution to the problem. For example,

Such a system may lead to harassment of subordinates and is inimical to the development of future commanders.

In a tactical nuclear war, extreme dispersion and radiation hazard may make commander visits difficult and dangerous.

Battle zone air control and intensive ECM of a sophisticated enemy would radically affect the command practice of helicopter visits, employed so extensively in Vietnam.

And, in general, the continuing trend toward increased troop mobility and dispersion tends to make extensive commander visiting impractical—even though commander mobility also increases—because the ratio of travel time to visit time changes so much that decreased travel time has little or no positive effect.

If commander visits cannot be relied on to fulfill all requirements, partial substitutes—improved human filtering mechanisms—are necessary to a truly effective CCSS. This system must be flexible and adaptive; it must be capable of changing in accordance with the demands of the situation and of the commander. It must, in effect, be a dynamic organism.

<u>A Filter-Distance Model</u>

To improve the human filtering operation, the workings of the filtering operation itself must first be fully understood; this can best be accomplished through the use of a simple model.

The commander in physical contact with a unit—acting as his own filter—is the ideal case, and provides a standard against which all other possible human filtering mechanisms can be evaluated. For any human filtering

mechanism other than the commander himself, three measures of effectiveness appear relevant:

1. *Physical distance.* As the filter is placed further from the commander, his ability to "see things the way the old man sees them" is likely to be impaired, and his effectiveness as a filter decreases. Physical distance from either the place of origin of the information (the unit) or of receipt (the commander) is relevant to effectiveness determination. The two distances may, to some extent, be traded off against one another or bridged by technology (as, for example, by the liaison officer who shuttles back and forth between two headquarters and who is equipped with effective technological communication devices).

2. *Psychological distance.* Persons who have never met, or who know little about each other, may perceive the same event or action quite differently. A human filter who does not know the commander well may find it difficult to understand precisely what interests him; conversely, the commander may experience difficulty in interpreting information transmitted through an unknown source. The precise and critical components of psychological distance, whether actual personal contact, familiarity, or simply the same thinking process, are presently unknown. Also unknown is the extent to which broadband width communication devices, such as television or videophones, can overcome all or part of the psychological distance separating any two or more persons.

3. *Organizational distance.* Two aspects of organizational distance appear to be relevant. First, whether or not the filter is responsible for the activity on which he is reporting affects the quality of the filtering. Second, absolute organizational distance is also significant; for example, the distance from company commander to his own battalion commander is quite different from the distance between the company commander and his corps commander. And the effect of using liaison officers from a higher to a lower headquarters also differs markedly from the effect of using them in the reverse pattern.

Application of the Filter-Distance Model

Before the model can be fruitfully employed in either analyzing or designing improved systems, values must be determined and assigned to the various combinations of the three distance factors; and to the specific hardware, organizational, or personnel techniques being considered.

As shown in Table 1, the "techniques" have been divided into three general categories: *technological, organizational,* and *personnel* (primarily selection and training). The "Xs" indicate areas of special and immediate concern. Let me offer some illustrative examples:

First, the *physical distance, technological* combination. By improving transportation, physical

Table 1. Preliminary Form for Application of Filter-Distance Model

Distance Factor	Technique		
	Technological	Organizational	Personnel
Physical	X	X	
Organizational		X	
Psychological	X		X

distance can obviously be reduced. However, such transportation improvements may also promote harassment and thus increase psychological distance. In any event, the development of quantitative relationships for various transportation modes is clearly indicated.

Psychological distance, technological. There is evidence that the increased availability of voice (telephone/radio) as opposed to written (teletype or courier) communication has enabled commanders to know their men better—that is, to reduce psychological distance. Whether further increases in technological communication bandwidth, say television or videophones, will accelerate this positive effect, and to what extent, remains to be determined.

Physical distance, organizational. Physical distance may also be reduced by organizational techniques. For example, liaison officers or other human filtering mechanisms can be placed at varying distances between the commander and the unit in action. Here again quantitative relationships are required.

Organizational distance, organizational. Organizational changes are an obvious possible solution to organizational distance. Specific factors to consider include use of liaison officers up as opposed to down, simultaneous reporting, directives to more than one echelon, and the like.

Psychological distance, personnel. Possible areas of investigation in this category would include the effects of special selection techniques, ranging from increased selection of key staff and subordinates by the senior commander to possible "psychological matching." Training and career development might include such techniques as maintaining a continued association of the commander and his key staff officers.

These examples are only illustrative of what must be considered. Ideally, precise quantitative relationships should be developed not only for each distance-factor/specific-technique pair, but for their interrelationships as well. In practice, it might be more fruitful to initially explore in detail a small number of especially promising combinations to provide concrete and usable data upon which hardware, organization, and doctrine decisions can be based in the near future. Research should accordingly be directed not at developing lists of information requirements and elaborate technological communication systems to transmit them, but toward understanding the rules by which commander, staff, subordinates, and hardware can be matched to achieve a flexible, adaptive, and efficient system.

CONCLUSION

This, in effect, brings us back to the point of departure. To know, for example, what kinds of display systems are required for high-level command-control use clearly requires that we first understand the needs and requirements of the users. If they are to satisfy *real* requirements, these systems must be flexible and must be acceptable to the senior commanders they are intended to serve. If, as suggested by our study of the "Art and the Requirements of Command", the personal-contact factor is critical, then any information-processing or communications systems designed for command-control use must be consistent with this requirement. On the other hand,

given the present training and indoctrination commanders and aspiring commanders now receive, a large part of the command-communication problem may be susceptible to equipment solutions. West Point cadets now being trained in computer science, in the use of sophisticated audio-visual devices and display, and indoctrinated into an an acceptance of the use of such devices as videophones, will approach the entire problem of information differently from present senior commanders. The overall problem remains the same, however: men, equipment, training, organization, and doctrine must all be meshed if the resultant command-control system is to be flexible, useful, and effective.

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2G. THE EFFECT OF ACQUISITION PARAMETERS ON AIRBORNE IMAGERY CHARACTERISTICS

(Unclassified Abstract)

Joseph A. Levy
U.S. Army Electronics Command
Fort Monmouth, New Jersey 07703

The specific effect which a particular imagery acquisition parameter has on the characteristics of the image is of vital concern to a field commander requesting an intelligence mission and to the G2-Air specifying the conditions of sensor deployment since these characteristics bear heavily on the interpreter's ability to derive information from the imagery. Several studies based on both empirical data and theoretical considerations have been run. The culling of results from studies based primarily on empirical data will form the basis of this paper. Particular attention will be paid to infrared and radar sensing and examples of typical imagery depicting particular parametric effects will be shown. Where applicable, sensor and interpreter performance curves will be exhibited which provide analytical basis to performance quality statements.

2H. COMMENTS ON SOME OF THE RESEARCH AND TECHNOLOGY NECESSARY FOR THE ENHANCEMENT OF HUMAN PERFORMANCE FOR MILITARY OPERATIONS

(Banquet Address)

The Honorable Donald M. MacArthur
Deputy Director (Research and Technology)
Office of the Director of Research and Engineering
Department of Defense
Washington, D.C. 20310

INTRODUCTION

General Betts, ladies and gentlemen, I am happy to participate in this 13th Annual Army Human Factors Research and Development Conference. I appreciate the opportunity to discuss some of the challenges and problems of DoD behavioral and social science research.

As most of you probably know, your fields became much more deeply involved in defense matters after April 6, 1917. On that day, a meeting of experimental psychologists under the auspices of the American Psychological Association and its president, Dr. Robert Yerkes, was being held in Emerson Hall, Cambridge, Massachusetts. A small special session was devoted to a discussion of how psychologists might assist the military effort. During the meeting, a messenger burst into the session with the announcement that our country had entered World War I. Dr. Yerkes and a small group of forward-looking psychologists immediately suspended the regular meeting. They energetically started a series of actions outlining what psychology could do for the national defense effort. Exercising his leadership in the profession, he obtained the spontaneous, unanimous answer from his colleagues. They recognized that military psychological research would be of great use to the nation in the time of crisis. Thus, in the spring of 1917 the first U.S. military psychological effort was born, starting on the problem of manpower selection.

A second important historical milestone was 1954. Dr. J. R. Killian, the Chairman of the Army Scientific Advisory Panel, set up a working group headed by the well-known Professor Harry Harlow to evaluate the Army's R&D efforts. This group's report recommended to Dr. Killian the acceptance and integration of psychological research as a part of human factors, behavioral and social science, into the Army's R&D activity. The recommendation was accepted, and human factors research activities were shifted to Research and Development. In time this became the pattern for the defense community as a whole. We believe that behavioral and social science research must remain in the Research and Development community.

Twenty-five years ago, perhaps even 15 years ago, a defense R&D meeting such as this--devoted to the behavioral and social sciences--would have been unlikely. But today, it would be unlikely to have any meaningful R&D conference without your participation.

EXAMPLES OF CURRENT DoD PROBLEMS

I would like to turn now to two examples of current DoD problems to highlight the needs and opportunities for research in your areas.

First, there is the problem of helicopter losses in Vietnam. For fixed-wing aircraft, loss rates from hostile action are much greater than loss rates from any other "operational" causes. But for helicopters, we sustain too many non-hostile losses. Although we need improved definitions and analyses of these non-hostile causes of helicopter loss, it is clear that much greater attention is needed to prevent them. This problem is particularly important when we consider the increasing use of helicopters and the planned growth in their performance characteristics.

Some of you are aware of the planning for the synthetic helicopter trainer system which may provide improved capability, particularly in emergency procedures. The problem is broader than this, however, for it includes: selection of personnel and their training; human performance capability such as pilot workload factors and work-rest cycles; helicopter design elements such as cabin noise levels and toxic gases, vibration, angular acceleration, visual perception and other factors. Clearly we need a systematic collaboration of the helicopter developers, the medical services, and the behavioral research scientists. For example, personnel selection and training methods must be considered in the engineering design process.

I am aware that efforts are underway, through the in-process review procedure, to obtain the views and support of the various talents needed in system development from the conceptual stages through hardware development. This is a step in the right direction, but increasing focus is needed to assure a genuine team effort so that all R&D contributions are fully integrated.

A second current problem lies in the development of laser applications. The development of laser technology, both in the United States and abroad, has been remarkable. The intensity of the light is of magnitudes that previously could be approached only by arc lights, magensium burning, nuclear weapons, and the sun. We all know of the hazards associated with the operation of lasers, particularly those emitting light in the visible and near infrared spectrum. Light at these wave lengths is focused on the retina, absorbed, and may cause temporary or permanent damage.

Some safety standards and threshold criteria have been developed through data obtained by the Army Medical Research and Development Command, Human factors engineering design assistance during laser device development almost certainly will help in the areas of controls, displays, alignment and operational techniques and procedures to enhance safety. It is absolutely essential for the laser developers to engage in a continuing dialogue both with the medical researchers and with you.

I have cited these two examples to show where many agencies, many

disciplines, and many insights must be coupled to solve urgent problems. I want to elaborate on this general issue.

ON THE RELATIONSHIP OF THE USER TO RESEARCH AND DEVELOPMENT

The goals and dimensions of research are necessarily somewhat different from the goals and dimensions of operation. The user wants an answer to his problems today. He states his requirements in operational terms:

Give me better students for helicopter training.

Give me better training programs.

Give me effective techniques for measuring behavior.

Give me an information system that will assure accuracy, completeness, and timeliness of output related to the "men in the system."

Give me some workable techniques for pacification in Vietnam.

The user has every right to request these products. They represent legitimate needs, genuine problems. But these needs and preferences are stated in terms too general to form the basis for research and development projects. It is in this area where coupling--real eye-ball to eye-ball discussion--between the users and the R&D groups in critical to develop specificity and responsiveness. In addition, if results are to be worth the research funds, they must first, be based on sound scientific findings, and second, be applicable to more than a single, highly specific situation.

Relating operational needs to research projects presents a dilemma that tends to plague the entire Defense research community. All other things being equal, with more time and more research, answers tend to be valid for longer periods of time, for more general situations, and under a wider range of conditions. However, the longer the research period, the less happy is today's user. He is less willing to wait and support the research, and he may have less assurance that the results will be useful for his specific problems.

What is the solution? As you appreciate, all of us wrestle with this problem continuously. A partial answer is that we must have an orderly program of long-range, mid-range and short-range research, and a set of development programs targeted for immediate applications; in other words a comprehensive RDT&E effort. This recognizes that in any problem area we must make some investment in the future. We cannot use all of our assets for user-oriented "fixes" to achieve immediate gains while mortgaging for future.

We have therefore organized the RDT&E activity under the categories of research, exploratory development, advanced development, engineering development, management and support, and operational system development. The DoD managers of behavioral and social sciences research have recently been taking greater advantage of this fundamental programming philosophy. However, this has a number of implications which I would like to discuss briefly.

Our standards of selection of projects are not merely whether the work is basic or applied research, or one of the various steps of development. We are instead deeply concerned with the relevance of the

work to defense problems, and with the overall priority of these problems. We ask whether the work has promise of producing products of a useful scientific nature and whether the investigator can meet his commitments. We cannot accept the argument that any "relevant" project is necessarily an "applied" project. We are committed to the belief that research can be both relevant and basic.

As work proceeds further into advanced and engineering development it becomes increasingly necessary to integrate it in greater detail with the final system. This implies an increasing degree of interdisciplinary coordination. It is most encouraging to note that over the past decade your programs have become interdisciplinary not only within the social and behavioral sciences, but with other disciplines as well.

As R&D programs come closer to implementation they require a closer interaction with the user. They also require a highly competent technical group to apply--carefully and cautiously--the R&D solutions. The time comes when the scientist finds user cooperation indispensable, and the user is eager to accept a successful product and put it into operation. For example, military training personnel have welcomed the HumRRO-developed instructional aids and procedures, and HumRRO has been greatly aided by being able to enter directly into the training process.

We want to support the finest talent in the country in R&D which is important both to the growth of science and to the solution of national security problems. We want to foster the type of interdisciplinary cooperation, and the researcher-user interaction, which will translate the scientific solution into operational effectiveness.

IN-HOUSE LABORATORIES

Let me turn now to a review of our thinking on the roles of the in-house labs. Clearly the in-house labs play a crucial role in the coupling process which I have been stressing.

During the 1960's, there has been consistent, high-level emphasis within the Government on improving the effectiveness of the in-house laboratories. Some progress has been made, particularly with respect to issues such as working conditions, job classification, facilities, personnel administration, and flexibility of funding. However, even more effort is needed to (1) involve our in-house laboratories more deeply in the central, meaningful problems; (2) achieve greater management stability and prominence; as well as (3) provide recognition to, and participation by, the in-house labs at the highest policy levels.

Actions that may help include:

(1) There are now plans to consolidate certain laboratories into major centers with a unifying theme, a direction resulting in part from the need for greater in-house laboratory involvement in meaningful problems.

(2) We believe there is a need for each of our in-house laboratories to be involved in the entire spectrum of the RDT&E program, from 6.1 Research through 6.5 Studies and Analysis. As I mentioned earlier, the Department of Defense has noted a past pattern of emphasizing mainly the early stages of research and development in the

behavioral sciences, and we endorse the recent moves toward increased funding in your areas within advanced development and studies and analysis. We must develop and test the "technology" of the social and behavioral sciences. This leads to my next point.

(3) Greater payoffs may be possible during the next ten years from better use of research findings and products of the past years. To date, inadequate attention has been given to the problem of imlementation of behavioral sciences research. The behavioral sciences could perhaps be better organized to apply scientific discoveries and to refine application once introduced. What we really need, as has been pointed out by others, are social and behavioral science "technologists"--people who can understand apply research, and who also can understand and assess operational problems. I know such people are scarce, but I believe we must manage our R&D programs to assist the development of this talent.

(4) The establishment of closer relationships between university departments in social and behavioral sciences and the DoD laboratories would be mutually beneficial. For example, we need senior faculty members who can serve as consultants on our regular advisory panels--and as special consultants to new programs. Often, we need part-time assistance for a few months. We especially need to involve the younger group of scientists--as consultants and perhaps as full-time investigators and managers. Too often, we tend to select only the "statesmen," and forget the group who will become tomorrow's statesmen. Similar close ties must be fostered between our in-house laboratory social and behavioral scientists and the appropriate professional societies.

(5) Finally, there is an increasing need for top management to be clearly informed regarding on-going research activities in the behavioral and social sciences. A recent Defense Science Board study of information available to top management, through the 1498 work unit research and technology resumes, indicated the inadequacy of these documents. Often they do not provide an adequate basis for understanding the intent of the research, the nature of the study design, and the kind of products anticipated. While it is clear that this problem applies to all technical areas, your assistance is needed to assure that such formal submission of information are accurate, meaningful, and up-to-date. I regard this as an especially important challenge--you must help much more in communicating and "translating" the results of your research.

Let me close by saying that your role in national security work is going to continue to grow, to become more critical, as we understand more deeply our national needs. As our hardware becomes more complex, the need for effective human control and participation becomes more urgent. We cannot afford to settle for anything less than first-rank social and behavioral science research to support national security activities. I would like to remind you of Secretary McNamara's point in his speech at San Francisco last month.

"Man is clearly a compound of folly and wisdom--and history is clearly a consequence of the admixture of those two contradictory traits.

"History has placed our particular lives in an era when the consequences of human folly are waxing more and more catastrophic in the matters of war and peace.

"In the end, the root of man's security does not lie in his weaponry.

"In the end, the root of man's security lies in his mind.

"What the world requires in its 22nd Year of the Atomic Age is not a new race towards armament.

"What the world requires in its 22nd Year of the Atomic Age is a new race towards reasonableness.

"We had better all run that race."

SESSION 3
KEYNOTE SESSION

A. KEYNOTE ADDRESS: General James K. Woolnough, USA, Commanding General, U.S. Continental Army Command, Fort Monroe, Virginia 22351

3A. KEYNOTE ADDRESS

General James K. Woolnough, USA
Commanding General
U.S. Continental Army Command
Fort Monroe, Virginia 22351

General Betts, Ladies and Gentlemen:

Standing before you this morning is a neophyte, but already frustrated, researcher. I suppose, perhaps, this puts me in compatible company with this audience as I am sure that no dedicated researcher is ever other than frustrated -- that is the fascinating part about the business. It's like golf!

The purpose of this conference, I am informed, is to improve the interchange of information on requirements, current accomplishments, and future plans among department of the Army Agencies concerned with behavorial sciences research and development, and thereby to reduce the level of frustration by attaining a closer relationship between these aspects of our endeavors in this field.

The conference theme "Enhancement of Human Performance for Military Operations" could -- to my way of thinking -- be stated as the primary mission of conarc. In order to give you some insight into Conarc's responsibilities for human performance, which we influence through training, I would like first to give you some idea of <u>what</u> our job is, and then review for you some of the current and past research activities which are contributing significantly to the accomplishment of this training mission.

Conarc's job is the meat and potatoes of the people business. It begins with developing the recruited or inducted civilian into a basic soldier. It goes through combining skilled soldiers and officers -- together with their equipment -- into a trained and combat ready unit and maintaining them in that condition. It doesn't ever really end, although we do have the responsibility of separating the individual from the Army when he completes his term of military service. And, now, we have the new responsibility of equipping him for his return to civilian life if he so desires -- project "Transition" of which you may have heard.

So that the new accession to the Army can learn first the requisite individual skills essential to sustaining himself in combat, and second his role as a team member, conarc maintains an extensive enlisted training establishment.

This training establishment is geared to receive the untrained civilian, process him into the Army, train him first as an individual to perform the basic duties common to all soldiers, and then train him in a specialty for which the Army has a need and he has the aptitude. I should emphasize that, within the governing factor of requirements, we try our best to match each individual to a job for which he does have the most aptitude.

Although in times of over-input there are exceptions, the tasks I have just mentioned are performed primarily at the 16 Army Training Centers where the newly drafted or enlisted accession goes through a three day period at a reception station for processing into the Army, including a battery of tests; a basic combat training period of eight weeks duration to learn the fundamentals of soldiering and to become physically and mentally conditioned to military life and discipline; and a later period which may vary from four to ten weeks in what is called advanced individual training for the specialized combat skills or in combat support training for skills common to all branches such as light vehicle drivers and cooks. A substantial number of soldiers going into the hard skill areas will be sent into the Army school system for longer periods of training, either after completing advanced individual training or combat support training or directly from basic training.

This is the way in which most of our incoming people make the fundamental transition from a civilian to a soldier. At the end of this individual training period, our new soldiers have sufficient individual skill to become a part of a new unit or an individual replacement to an established unit, either in the continental United States or overseas. He may already have achieved the enlisted grade of E-3 if his performance has been outstanding.

From the weekly output of basic training centers, selected individuals are trained in the more complex skills required to operate and maintain today's sophisticated equipment: either by on-the-job training in a unit, or by attendance at one of conarc's 26 service schools. These schools teach hundreds of courses and provide both officer and enlisted specialists in more than 310 military skills. The schools range in size from a few hundred students a year at the Army chaplain school to more than 50,000 a year at the southeastern signal school at Fort Gordon, Georgia.

For commissioned officers, branch qualification from basic to advanced skill level is also provided in the conarc school system. To fulfill this responsibility, we must determine the course length, content, curriculum and standards for each school and are responsible to, and governed by, the training requirements placed on us by the Department of the Army.

Two major programs within our conarc school system which have undergone rapid expansion in response to the demands of our operations in Vietnam are the officer candidate schools (OCS) and aviation programs.

Between July 1965 and July of this year, we tripled the output of second lieutenants from OCS. This was achieved by initiating 23 week OCS courses at additional service schools and expanding those already in operation. However, we have recently received a directive which will reverse the trend and

drastically reduce the input, with only the infantry, engineer and artillery OCS programs being continued.

I am particularly proud of our warrant officer flight training program. After 8 weeks of basic training at Fort Polk, Louisiana, for new accessions, volunteers for this program complete 32 additional weeks of training at Fort Wolters, Texas, and Fort Rucker, Alabama. Then, in most cases, they are sent directly to Vietnam or to units scheduled for deployment there. We are now producing more than 400 fixed and rotary wing pilots a month and are building up to a 610 rate by next year.

To give you an idea of the magnitude of the total training job done by conarc, during the period 1 July 65 through 30 June 67, over one million, one hundred men graduated from basic combat training. Of these, 65 percent went on to advanced individual training while another 25 percent attended courses at conarc service schools. At the same time, more than 85,000 officers graduated from courses at conarc schools plus 24,000 OCS graduates who were commissioned as second lieutenants.

Conarc now also has primary responsibility for the Army ROTC program, subject to policy direction from DA. Since its establishment by the National Defense Act of 3 June 1916, the Army ROTC has undergone significant expansion. Today it is being conducted in 247 institutions of higher learning with an ROTC enrollment of about 180,000. It is estimated that the program will produce approximately 18,000 junior officers during the present school year. This group in particular will be interested in knowing that our new ROTC graduates who have unusual scientific skills are now often assigned directly to a job in which their skills may be applied immediately upon entry into active duty.

One of conarc's major tasks in the immediate future is that of continuing to improve both the substance and the image of the ROTC program to the end that it will enhance the Army's stature by attracting the best quality of potential officers available on our college campuses. I hope we can count on your support within the academic community in achieving this objective.

Beyond our responsibilities for the training of the individual, we also have the responsibility of training units and readying them for deployment when so ordered by DA.

Our unit training program, like our individual training program, is divided into basic and advanced training. The basic unit phase provides training in the performance of skills required by a fire team, weapons crew or squad, and ends with the successful completion of company or battery level proficiency testing. The advanced unit phase trains company size units as a part of battalion level teams, provides combined arms training -- infantry, artillery and armor working together -- and training in special operations such as amphibious, jungle and counterguerrilla training. This phase is culminated by proficiency testing at battalion level.

The pinnacle of our unit training program comes with the field exercise which provides opportunities for our larger units, with their supporting forces, to operate as

fully integrated combined arms teams. But even at this pinnacle we still find both our major strengths and weaknesses have their genesis in people; the same kind of people who are the subject of your research.

This is why conarc offers the most unique and complete research laboratory in the whole people business.

Last month, while on a visit to Fort Benning, I attended a class in the leaders reaction course which was being given to our new noncommissioned officers candidate course. There were some dozen cubicles in which groups of the candidates were being faced with a number of difficult situations for solution by their appointed leader. All cubicles could be observed by walking around a sort of cat-walk above them, and it had been the plan that I should observe each situation for a minute or two, then move on to the next in order to get a general idea of how the course was run.

I never got beyond the first situation in the total time allotted for the visit to this class. I believe a qualified scientist could have made a lifelong study of the human factors involved in that one little tableau. General Wright was much amused at my reaction; he confessed the same thing had happened to him on his initial visit. Any time you need a little original research human factors laboratory, let us know!

If I were asked to state the broad objective of our training program, I think the answer would be that it is to maintain the world's most powerful Army. To accomplish this objective, we must, among other things, continuously keep abreast of American youth's interests, aptitudes, capabilities and potential upon entry into the Army. Then, we must gear the training in our schools, training centers, and units to these characteristics in order to meet the requirements of the Army worldwide from the material at hand. This calls for a constant and dynamic military effort supported by timely and diligent research. I think we have such a program.

Let me cite a few examples:

To assist in the expansion of our aviator training program, a synthetic flight training system has been designed and is now in the hardware training device developmental stage. It is to be used at the aviation school and conus aviation field units and promises to provide considerable cost savings and more efficient, standardized helicopter instrument and transition training.

A very comprehensive research survey concerning training and career requirements for warrant officer aviators, which will be considerable value to our policy makers in that area, is underway.

Much research has been and is being accomplished in the area of training objectives,training methods, and quality control. I am particularly impressed with the possibilities of the Mos Data Bank now being developed under DA auspices.

An elective course in training management has been designed and pilot model tested by a research agency in the advanced officers course of the Armor school. Following refinement, this course will be available for the other schools desiring to incorporate it as an elective.

A new officer candidate leadership prediction test, designed through research and recently implemented, will hopefully give us a better predictor of success or failure and thereby lower attrition rates in OCS without lowering standards.

Country handbooks and counter-insurgency studies, resulting from research, are being employed as instructor references and student texts in our special warfare and civil affairs schools.

Under project 100,000 the Army is receiving a sizeable number of lower mental category individuals. This is obviously a challenge to the flexibility and responsiveness of our schools and training centers. To assist in meeting this challenge several research projects and requests for technical assistance have been initiated.

Several research projects are currently underway which hold considerable promise for improvement of our radio and radioteletype operator training through reduction of attrition, shortening of course length, and greater retention of learning.

We have greatly expanded our use of programed instruction over our pioneer efforts of only a few years ago and are continuing to exploit this training medium in more of our courses of instruction.

Educational television within conarc has progressed to the point where we now have television support for 23 of our service schools and 11 training centers.

Conarc, with its eyes on the future, will follow and monitor with interest the chief of research and development's project on computer administered instruction.

One facet of this innovation, concerned with basic electronics instruction, is being explored concurrently by our signal school here at Fort Monmouth. The infantry school and quartermaster school are also involved in plans for experiments with computer supported instruction.

These examples are indicative of conarc's continuing interest and accomplishments in the behavorial sciences R and D program and of our continuous search for ways and means to improve our training capability.

But, just because the past record looks good, we are not satisfied to sit on our backsides and view with pride that which has already been accomplished. We must find ways to exploit more fully research results, and to guide new research along lines most valuable in meeting the Army's objectives. Permit me to Quote from a report prepared by the Army Research Council which was published in late spring of this year:

(Quote) "Active involvement of the Army in science and research should assure that the results of research, where done, are applied to solve Army problems. Individuals are needed who are experts in scientific and military fields. They bridge the gap between research results and ideas and practical military applications. Such experts minimize the lead time between the generation of a scientific concept and its Army application. They must continually make critical evaluations of new ideas or research results to determine their applicability to Army problems." (Unquote).

This statement is perhaps a good one on which to terminate my key-

note remarks to this distinguished audience. I think it is a pretty fair summary of what should be expected of the military experts in this field and I will not attempt to embroider on it.

But I can assure you, military and civilian alike, of conarc's full support of your projects which could lead to a better accomplishment of the people-oriented conarc mission.

SESSION 4
IMPROVEMENT OF HUMAN PERFORMANCE IN OVERSEAS OPERATIONS

Co-Chairmen: Nelson Spinks
Center for Research in Social Systems
American University, Washington, D.C. 20016
and
Donald Stanley Marshall, Lieutenant Colonel, USA
Office of the Deputy Chief of Staff for Personnel
Department of the Army
Washington, D.C. 20310

4A. INTERRELATED FACTORS AND SYSTEMS THAT AFFECT NATION-BUILDING – DEPICTING A RATIONALE AND APPROACH TO ARMY ANALYSIS OF OVERSEAS OPERATIONS

Donald Stanley Marshall, Lieutenant Colonel, USA
Office of the Deputy Chief of Staff for Personnel
Department of the Army
Washington, D.C. 20310

The Problem

Just as we may reiterate John Donne's ancient truth that "No man is an island--"[1], so we must recognize today that no nation is, or can be, completely isolated from the impact of other nations activities. The future course of each nation is related to the degree of political stability and economic progress of other nations; the state of mental well-being of each citizen increasingly must reflect the degree of physical security and the socio-psychological state of other citizens in our diminished world.

The U.S. Army is, long has been, and for the forseeable future will continue to be involved in operations in some countries to support the process of nation-building, in furtherance of our national objectives and policies. This support now is most critical in Southeast Asia, but to one degree or another pertains to other areas. If we are to improve our performance, we must understand the total process that we attempt to influence in achieving our US objectives. For no activity can be more complex, nor operation subject to more dependent and independent variables, than are the interrelated systems, factors, and sub-factors that characterize the overall nation-building process. Whether working for the Army or other Department of Defense service, Department of State or other government agency, missionary endeavor or philanthropic foundation, our United States planners and operators must take into consideration the total nature of human (and other) factors and their interrelation.

Neither industrial managers nor political planners of past generations have taken much account of the nature of man; they have not had the tools to do so. But, given intelligent guidance this need not be-- indeed, must not be-- the case in the future.

Approach

The work reported on in this paper had its genesis in the author's attempts, as a very junior officer in World War II, to interrelate US Army needs to the cultural patterns of the San Blas (Cuna) Indians of Panama. Realization that dealing with such people in terms they understood could lead to productive results-- but that we knew very little about such alien

terms-- led to a career in the field of anthropology. The study of anthropology led to a realization that there now exists a vast store of archival and theoretical knowledge that would be useful to administrators, if only they knew that it existed-- and if it could be translated in terms that were comprehensible to them. Further study of anthropology over the past 18 years, utilizing the "generalist" point of view of a military background combined with the field approach of an ethnographer studying total island culture in Polynesia, led to a finding that integrating the individual disciplines of the "social sciences" could lead to a useful overall approach for understanding human behavior. [2]

An opportunity to participate with other Department of the Army "specialists in uniform" in the PROVN and CAST study groups, analyzing situations in Southeast Asia, led to a transferance of the earlier approach of studying exotic Polynesian island groups into an approach to studying small nations. Conceptual models were applied to analysis of nations under the stress of insurgent warfare, and the musings of academia were translated into action documents.

It should be understood that part of the approach here labeled "General Anthropology" would be familar to so-called "Systems Analysts" or "Operational Research" specialists. Briefly, it reflects an assumption that if one can determine, understand and describe the significant factors-- and their relatedness-- that go to make up a particular situation, one is then in position to predict a future course of events. One even may direct the change in direction of that course of events-- providing that one can obtain sufficient resources and can control sufficient variables related to that situation. Major stress must be placed upon the complex interrelatedness of human factors, implying that factors cannot be dealt with in isolation. Therefore, fundamental principles that underly the military services unique planning and staffing system must be incorporated in any operational approach to directed change of a situation-- to include those programs aimed at nation-building.

Essentially this view reflects the application of cautionary words by Joseph Henry (1797-1878), the First Secretary of the Smithsonian Institution: Not only does "Modern civilization depend on science", but:

> "...knowledge should not be viewed as existing in isolated parts, but as a whole, each portion of which throws light on all the others."

The chief contribution of the general anthropologist to such studies, is to insist that analysis of real-world situations must recognize this interrelation, and must reflect personal field contact and interaction; it must not be based solely on archival or formal report materials. Field observation provides the context for interrelating separately analyzed sets of data. Further, the anthropologist insists upon an understanding and application of the technical concept of culture and it's processes, as opposed to the conventional aesthetic definition.

Results

One result of nation-building studies is the graphic depiction around which this paper is built. The completed figure, supported by

MAINLAND SOUTHEAST ASIA

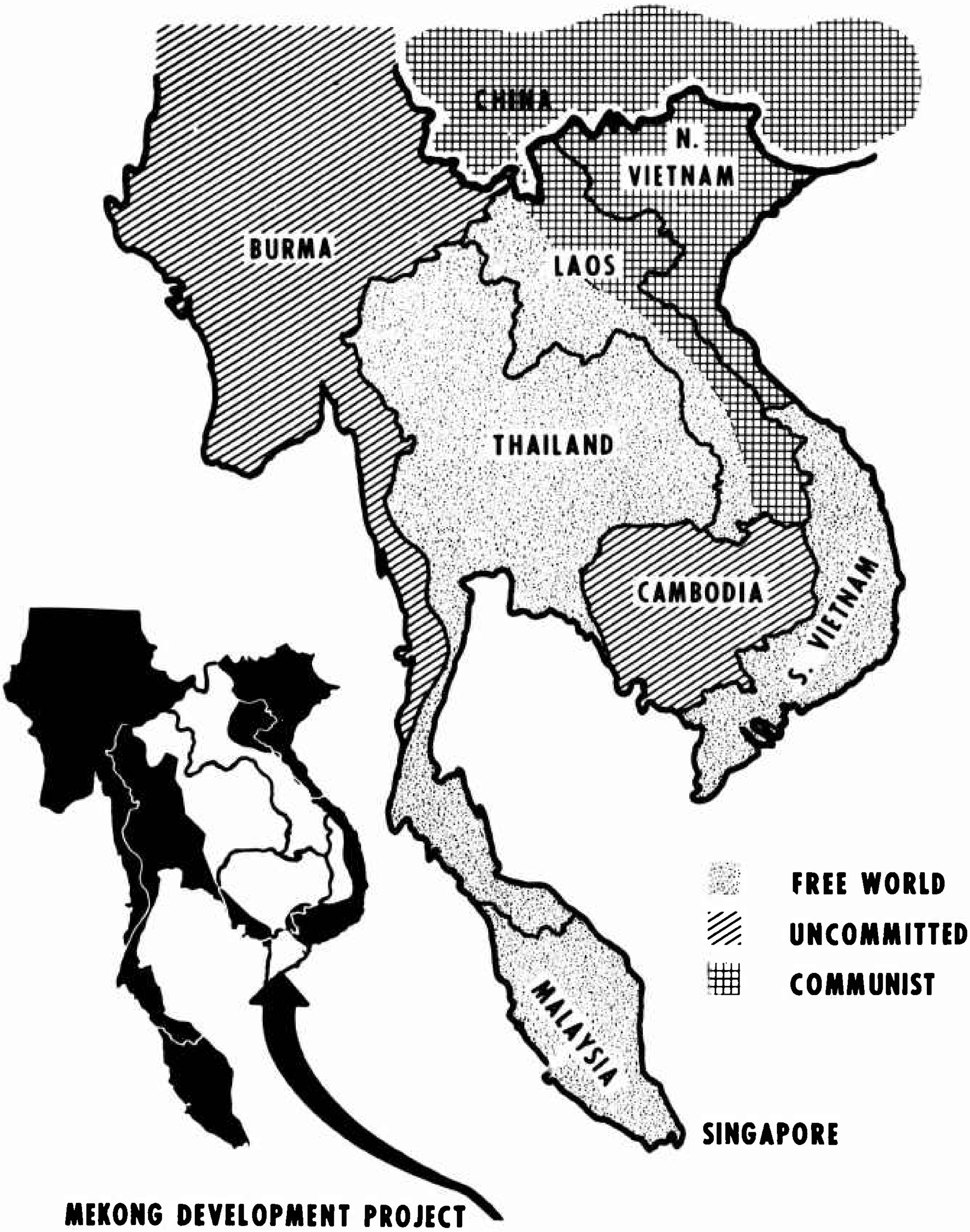


Figure 1

FACTORS THAT AFFECT NATION BUILDING

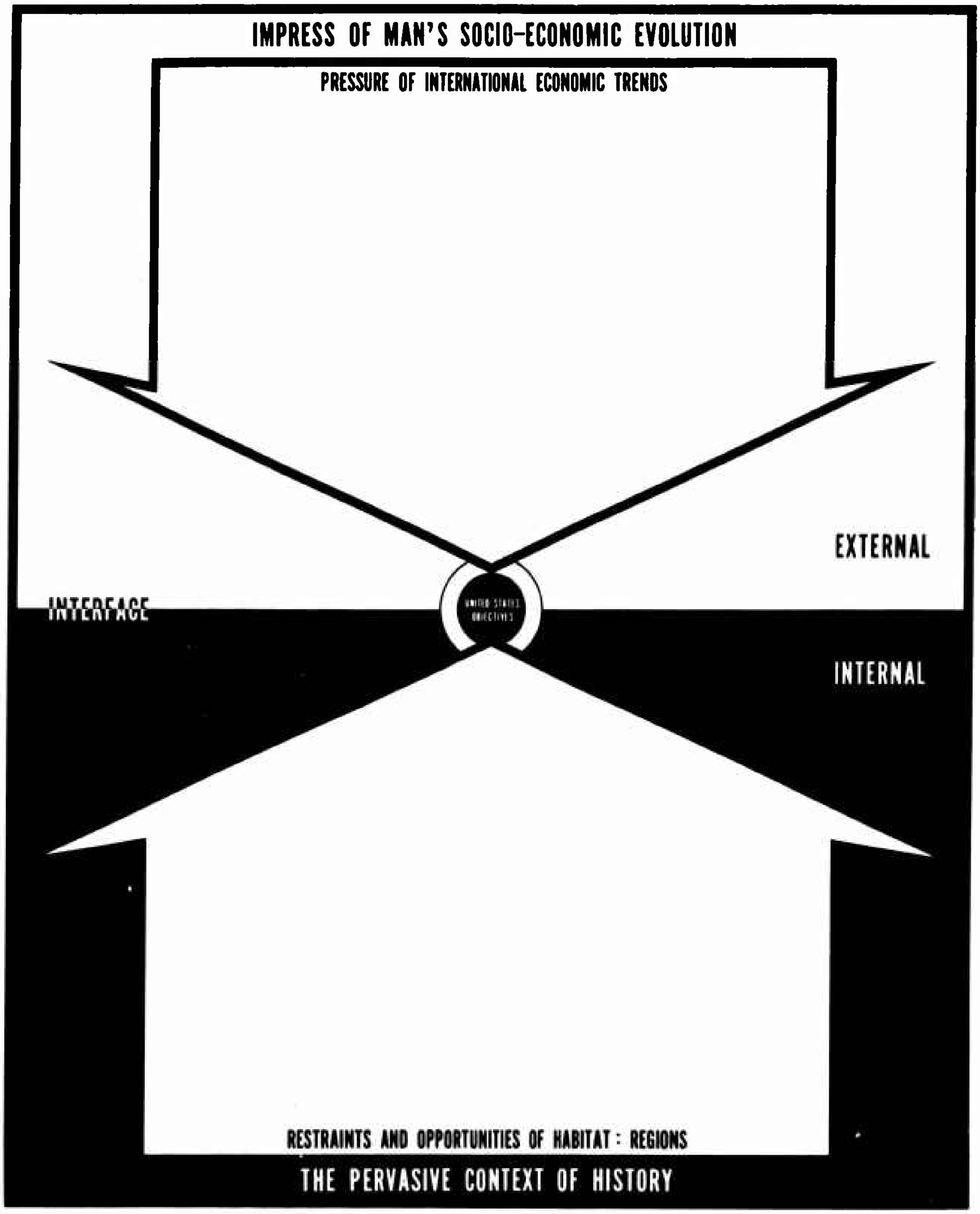


Figure 2

a discussion and detailed amplification, could provide a ready "check list" for ensuring that significant factors are considered in developing plans and programs at the national level, as well as a vehicle for indoctrinating personnel preparing for overseas operational missions. Let us be agreed, however, that this schematic represents only "one way to slice the pie" and is merely a mnemonic device to interrelate ideas; it does not mirror activities. The concept labels encompass different levels of abstraction and have varied degrees of significance.

First, refresh your memory of the tangle of countries in Mainland South East Asia by reviewing figure 1: those that penetrate like a dagger from their Communist World neighbor of Red China are North Vietnam and the Eastern portion of Laos; Free World countries are beleaguered South Vietnam, together with Thailand, Malaysia and Western Laos; the Uncommitted Nations are Cambodia and Burma. But note for your future reference the immense area covered by the Mekong Development Project, a joint venture that indicates the potentialities of regional cooperation-- even between nations still at variance-- hence, an omen of hope!

Because of significant current events, and the scope of modern news coverage, sufficient examples can be provided by brief allusions reflecting the inter-play of those principal factors we discuss.

The first point to be made is that if we are to understand anything of-- and to favorably affect-- the situation in Mainland Southeast Asia, in relation to our national objectives, we first must comprehend the significance of The Pervasive Context of History (see Figure 2). The term "pervasive" is stressed because one cannot begin to understand the real problems of Southeast Asia-- for example: the mutual suspicions, the differentiation between elite and commoners, the lack of communication between governors and those governed, the lack of the countryman's personal political concern and commitment, the so-called "corruption"-- unless one is fully cognizant of the impact of the ceaseless flow of conquering armies, the successive colonizations, the treacheries, the infusions of Indic religious concepts, the Sinitic administrative systems and the procession of covetous European entrepreneurs and invaders that fill the historic pages of the past in Southeast Asia.

Further, one cannot comprehend the courses of the past or the possibilities of the future without full realization of the meaningful Restraints and Opportunities of Habitat. For the rich goals that have caused a constant clash of armies in the plains and deltas of Southeast Asia are their ricelands and river systems. And the very mountains that have channeled the flow of invading conquerors have at the same time provided refuge areas for the conquered and the backward, and a perpetual retreat for bandits. Today these same refuge areas provide a base of operations for terrorists and subversive elements who seek to destroy what we attempt to support, and to burn what others build.

Constantly influencing those Internal factors that relate to nation-building are External factors, popularly summed up as "Modernization", but better defined as the Impress of Man's Socio-Economic Evolution. No planner or manager can afford to not understand that powerful forces at loose in the modern world, often referred to as the "Revolution of Rising Expectations," simply cannot

FACTORS THAT AFFECT NATION-BUILDING

[SOUTHEAST ASIA EXAMPLE]

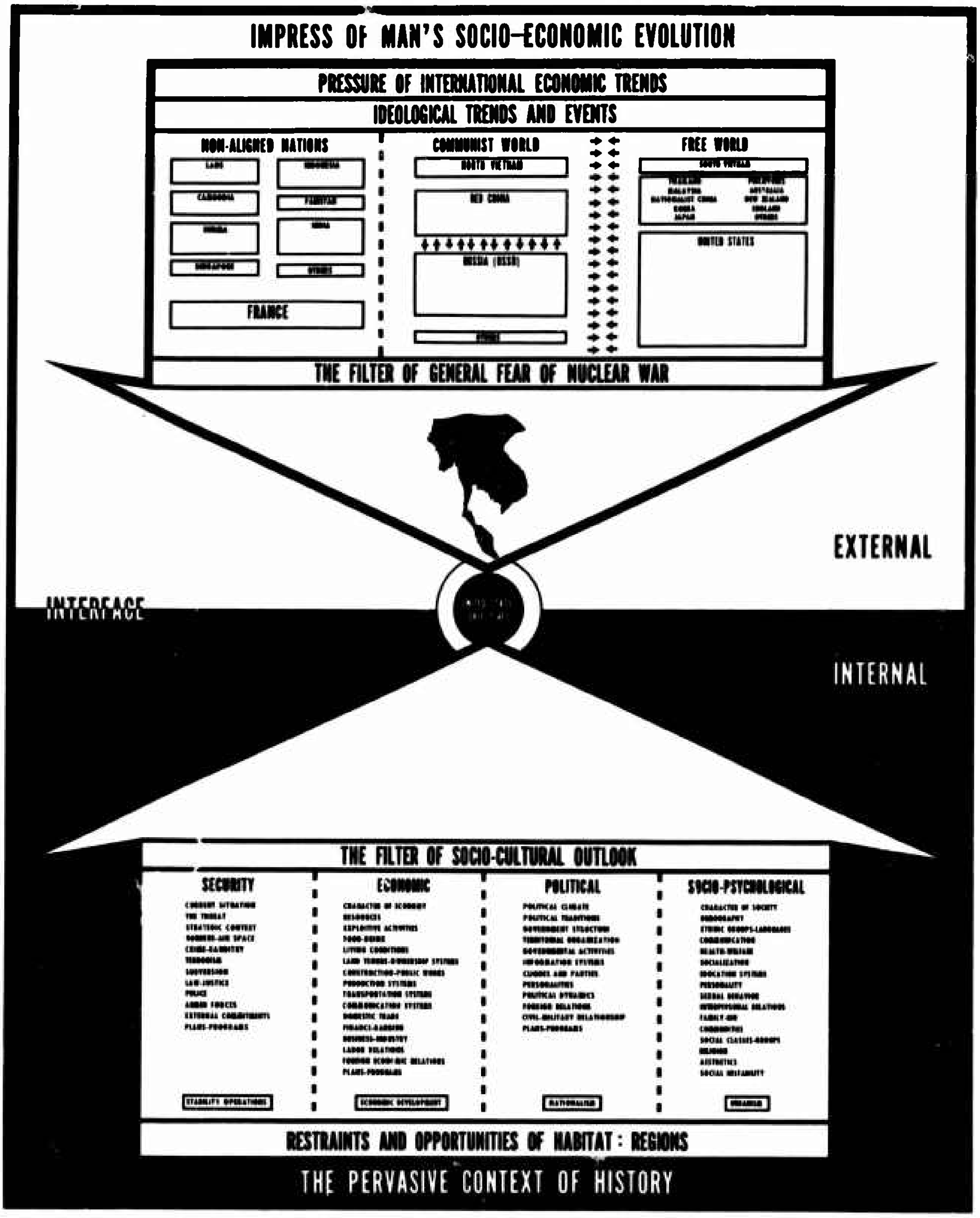


Figure 3

be eliminated. Men today cannot escape the promises of all idealogies: political equality, economic betterment, physical security and an opportunity for individual expression and fulfilment.

Similarly, the Pressure of International Economic Trends and Events leaves few individuals untouched: increasing use of synthetic substitutes and the increased productivity of South American and African competitors forces an ever-downward trend to the rewards of rubber growers in Southern Thailand and South Vietnam; in contrast, political differences between England and Rhodesia jump the profits of tobacco growers in Northern Thailand just as requirements for Kenaf open attractive possibilities to farmers of the Northeast; and Japan takes corn raised by farmers in the West.

The Interface between External and Internal forces and factors represents the area where representatives of the United States (best referred to as the U.S. Mission) can-- in conjunction or in competition with representatives of other nations, regional and international organizations-- provide knowledge, experience and national assistance that will aid other selected nations to build the internal strength and achieve the economic and political viability that they desire and that fits our National objectives.

The objectives of the United States are not necessarily shared by other nations, in their own efforts to influence the direction of the nation-building process, as is depicted by Figure 3.

Conflicting Idealogical Trends and Events in the Free World efforts to block power plays by various Communist World nations, together with the impact of contending nonaligned nations, may be amplified by-- or themselves amplify-- the stability situation in developing nations. The actions taken by such a uniquely significant independent nation as FRANCE-- whose past connections with Southeast Asia have been so intimate-- may have an impact upon nation building efforts of Southeast Asian countries, both externally and internally.

For better or for worse, there now is a single factor that ameliorates and modifies the major decisions of all nations. The General Fear of Nuclear War not only provides a constant dampener of conflagrations; it is likely that never again will a military Force Commander of any nation be given his mission without the accompaniment of specific limitations on objectives, weapons use, and force size.

But, more complex and less subject to short-term remedies or negotiations than are these External relations between ideological competitors are the supremely critical factors of the behaviorial patterns of citizens and inhabitants of those nations we are assisting to build; the Internal.

Bound together by the Filter of Socio-cultural Outlook (a substitute phrase for the much-maligned, controversial and difficult-to-determine term "national Character") are the multitude of factors that affect what any one man, varied groups of men-- or the nation itself-- may do, or how it or they may react. Not until we have achieved an understanding of the interrelation and the proportionate significance in the national, regional and local setting of these factors we list under the conventional headings of Security, Economic, Political and

Socio-psychological can we realistically begin to achieve those goals we establish in our National objectives.

Such achievements, for example, may arrive only when we (whose borders are lightly regarded, in view of our good neighbors to the North and South) can begin to appreciate the intensity of feeling of the governing elite of a country such as Thailand concerning their borders and airspace, and relate this feeling to their past millenia of successive wars caused by border invasions. And only when we (who generally have been wage-earners in a society that usually pays a living wage) can understand the frustration of officials who are not paid an appropriate living wage, but whose predecessors for millenia have taken "tea money" for providing individual services to individual citizens, can we begin to help resolve the problem of "corruption". Only when we (who have been raised in the traditions of a citizen's right to dissent or to demand) can comprehend the attitude of citizens who never have, and hence do not wish to begin to exert influence upon or communicate with their governing officials, can we begin to help resolve the problem of developing responsible officials and responsible citizens. And only when we (nurtured in concepts of "conservation of wild life" and "save our forests") can understand that through hundreds of years of cumulative social experience, some groups of people have developed a relationship with their forest habitat that permits a slash-and-burn agriculture that uses effectively what would otherwise be useless terrain, can we begin advising other nations what to do about governing their tribal societies in the hills.

There are dozens, if not hundreds, of topics or factors about which we must be informed. Some are shown on Figure 3. But the critical points to be summarized are these:

1. There exist in libraries and archives of the world, and in the minds of an immense variety of individuals, useful knowledge that is not being used-- and that must be used, if we are to succeed.

2. There are some topics about which we do not have information, but for which data can rapidly and effectively be obtained-- if we know whom to employ and how to employ them.

3. Until the specialized knowledge and problems associated with single factors are put together in the full context of interrelated relevant factors, attempting to resolve one problem may simply multiply other problems.

As an example of Point Three: The assertion often is made that roads are "the" first priority answer to rural economic development, because they enable the countryman to get his goods to market. But planners forget that roads are a two way avenue of communication, bringing new socio-psychological forces into an area as well as providing an outlet for disposing of material goods. Roads must be maintained; they are traveled by vehicles that must be obtained, driven and maintained. They occupy terrain that once was used for other purposes. To sophisticated manipulators of men and material, the disposition of such terrain provides immense possibilities for personal gain which frequently leads to dispossession of rightful owners. Such roads, no matter how simple,

require machinery for construction and materials for development. Roads allow easier access to either governmental or to anti-governmental forces. Roads change social, economic, political and military patterns and relationships; there is very little, in the human factors of areas served, upon which road development does not impact.

Interpretation and Conclusions

What is the meaning of this preliminary depiction, for action-oriented planners? Our discussion at this point is related solely to the implications of the complexity of forces and factors that are shown in such an over-simplified version, and to which I have briefly alluded:

Without question, the complexity and intensity of the forces and factors portrayed make clear what historians have already known:

1. Change, including change in the nature of nations as well as in the physique of animals and of men, is inescapable; to unduly hamper or attempt to preclude change is to invite death.

2. Factors of change are inextricably interrelated; to vary the intensity or the nature of one factor cannot help but impinge upon the intensity and the nature of other factors.

The multiple factors set forth in Figure 3 and in the preceding discussion negate simplistic arguments by those who contend that "the solution" to problems in Southeast Asia lies only in "killing the Communists" or "more combat divisions" or "negotiations," or "leave the country to the obvious regional power, China." Varying such factors may influence some of the other factors, but such manipulation cannot assure control over sufficient numbers of them to achieve an objective. This very interrelatedness of factors is what makes the development of solutions so difficult. If the factors were independent variables, it would be relatively easy to resolve the situation by addressing each problem with a separate program for solution-- an effort that characterizes much of our past efforts in Southeast Asia. But, the development of an integrated plan which will take all of the dependent variables of the factors into consideration becomes incredibly complex.

Considering the multiplicity, conflict between-- but interrelated nature of-- those factors shown, it must become clear that any national action plan purporting to attack a problem of the complexity of the present situation in Southeast Asia must:

1. Set forth a clear and unequivocal ultimate objective, and specify the principal means and steps essential to achievement of that objective.

2. Demonstrate that it has isolated those factors impinging upon the situation, and that it has related such factors both to the objective and to the means of achieving it.

3. Provide evidence that its action-phasing has incorporated a means of controlling the impact of those factors involved upon ultimate achievement of the objective.

At the national (and, in some cases international) level of the regions concerned there must be developed planning staff groups that can collect, integrate, analyze, utilize and depict appropriately the

necessary immense body of data to enable decision makers to act upon management requirements in a more informed fashion in the future than has characterized the past. And such a planning and analysis group must exist at the Mission level of the United States support team, in-country. For we cannot advise appropriately upon matters the full impact of which we do not understand. Needless to say, we must have managers of the U.S. effort who fully understand the significance and need for, and will utilize, informed and completely integrated planning.

Fully as important for success in nation-building as is an appropriate staff and a dedicated manager, is the need for our own commanders, our providers (the Congress and the taxpaying public)-- as well as the government and citizens of the country being supported-- to realize the need for time. In dealing with human factors-- the attitudes and the culture patterns of conservative peoples-- we are attempting to influence a patterned response to situations that has been built over hundreds or thousands of years of human experience. Such cultural answers to human problems have had the benefit of generations of trial and error. Hence, to find better answers and to direct and to manage behavioral and attitudinal changes takes time--not weeks or months, but years and generations. There is an imperative need for continuity of effort-- for longer tours of service, and for offices of record, to preclude short-lived institutional memories that lead to costly repetition of the same mistakes, rather than profiting from experience.

One final conclusion related to the implifications of the many factors involved in nation-building: Our national objective, from the standpoint of the military mission, supports the requirement for "stability operations". We do not yet have an agreed upon national doctrine of support. In developing such a doctrine we must make inherent in the definition or concept of "stability" itself the provision for accomodation to change. Such a concept cannot be permitted to become synonymous with "status quo", for "status quo" in itself is a guarantee of instability, owing to the dynamics of interplay of those factors depicted. Instead, we must develop a concept of national stability so related to balance of internal and external forces as to provide limiting action to overemphasis upon-- or unbalanced solutions to-- security, political, economic, or socio-psychological problem areas.

Problems and Requirements

To expose a problem is not to solve it. In pointing out the nature and complexities of factors related to nation-building, it becomes clear that probably no single individual that our nation may have available for service today is adequately qualified to solve problems in all of the diverse but interrelated fields of political, economic, security and socio-psychological behavior. Yet all of these fields are intimately related to nation-building, to stability operations, and to "counterinsurgency". Clearly the answer must be team effort-- in support of an aggressive manager. But, we do not as yet have a doctrine for such a team effort, nor have on hand many potential team members with fully appropriate breadth of training.

Because of the Armed Service's "generalist" approach and insistence upon planning, the time-tested nature of the military general staffing

procedures and the armed services appreciation for education, together with their ready use of the assistance of scientific and academic research support, it would appear that we have an appropriate foundation to lead the way in better resolving nation-building problems. Needless to say, we are intimately involved operationally. But, in the Army we do need to better solve some of our serious personnel problems: more careful selection and evaluation of advisors and representatives; much longer lengths of tours, professional "career" recognition and the value of nation-building contribution and experience as compared to combat-leadership roles.

But, I am persuaded we can do the job--if only because by this session we have given evidence of our understanding of the need for, and willingness to tackle the "Improvement of Human Performance in Overseas Operations."

NOTES

1. "No man is an island, entire of itself; every man is a piece of the continent, a part of the main". John Donne, 1633

2. See: Donald S. Marshall, "General Anthropology-Strategy for a Human Science", Current Anthropology. Volume 8, Number 1-2, Feb-April 1967.

4B. IMPROVING INDIGENOUS MILITARY PERFORMANCE THROUGH THE ADVISORY SYSTEM

Richard P. Joyce and Robert H. Williams, Brigadier General (USMC Ret.)
Research Analysis Corporation
McLean, Virginia 22101

The Advisory System

The modern US military advisory system is a complex thing comprised of treaties, agreements, Executive Branch commitments, legislative acts, overseas (Unified Command) theaters and sub-theaters of operations, Military Assistance Advisory Groups and Missions, military materiel production and storage facilities, lines and modes of transportation and communication, and military and civilian schools, colleges, universities, and other institutions of training and education, all of which have been interdependently related for a variety of purposes having to do fundamentally with the national security of the United States. The history of this system spans a full century but does not reveal a process of orderly evolution. With but few exceptions, US military advisory missions to foreign countries prior to World War II were occasional things in which US Service Departments took little official interest. With the announcement of the Truman Doctrine in 1947, however, US military advice and assistance to foreign countries became a major instrument of US foreign policy and the advisory system as we perceive it today really dates from that time.

There are many ways of looking at the present system with a view to improving its performance, and truth is that government and private corporate executive managers, scholars, legislators and other interested persons and bodies are constantly scrutinizing the system and tinkering with its machinery to see if it cannot be made to run more smoothly and efficiently. Indeed, upon occasion some have evern been known to throw the proverbial monkeywrench into the works, more we would hope out of frustration with their inability to understand how and why it really works than out of desire to put an end to its operation.

Counterparts

But from whatever vantage point one chooses to view the system, it is inevitable that he will see people--human individuals, who may

FOOTNOTE -- The opinions expressed in this paper are those of the authors and do not necessarily reflect the official policy or position of the Department of the Army.

for purposes of our discussion today be grouped into two sets--those charged with the responsibility of making the system work, and those for whose benefit the system is supposed to work. These sets are counterparts of one another and within each set, each individual can be identified with one or more counterparts in the other set.

Some of these counterparts may be only vaguely aware if at all of the other's existence. By way of far-fetched example, that element in the system represented by the man somewhere in our defense structure who ultimately dispatches 10,000 mess kits to the Army of Country X to enable it to feed itself on D+10, undoubtedly has a counterpart in the defense structure of Country X patiently awaiting receipt of those mess kits at the other end of the pipeline. The two individuals are counterparts who probably have little awareness of and even less interest in each other's existence.

But if these two counterparts were to meet, the one to deliver and the other to receive those 10,000 mess kits in direct exchange, the US individual might say "this is the second time in the last five years that I've sent you 10,000 mess kits, you must be expanding your Army." "Far from it," might be the reply, "the last 10,000 you sent me were terrible! The 5,000 that we put to daily use are no longer useable because of broken handles and when we went to our open-air storage yard to draw on the other 5,000 that we had put there, we found nothing but a pile of rust."

The point of this little "make believe" is simply that the capability of Country X's Army to perform mess kit repair and preventive maintenance stands in obvious need of improvement and that the improvement process must begin with all persons who are in any way responsible for mess kits in Country X's Army--soldiers who must learn how to care properly for their mess kits, through mess kit repair battalions which must learn how to systematically go about recovering broken mess kits, and repairing and returning them to service, to Quartermaster depots that must learn how to prevent mess kits from rusting away while in storage. Given the US advisory system as it currently exists, and overlooking if you will, the fact that alternatives to it do exist, the required improvement in individual and organizational performance in the Army of Country X will be sought through the assignment of US Army advisors to Country X's Army.

With this brief and admittedly over-simplified review of what the US advisory system is and how it tends to operate, I will now dwell for a few minutes on two problem areas that arise immediately with the decision to provide Country X with the US Army advisors in an attempt to upgrade X's performance capability. These concern:

(1) the US Army advisor in a foreign cultural setting, and

(2) the Army management problem of programming qualified men into advisory service.

Logically, the second of these two problem areas is the first that is encountered in implementing the decision to send advisors to Country X, and the history of US advisory operations shows clearly

that as a result of the accumulated experience of advisors in the field is the problem is being increasingly recognized to have urgent importance.

The Advisory Task

I will explain. Originally, it was thought, and some Army persons still believe, that an advisor's job is simply to show foreign personnel how to use and care for US equipment. At first glance, the example of the mess kits would seem to bear out this view but a closer look at that example shows that it pointed clearly to the probable organizational needs of Country X's Army for a mess kit repair battalion and an improved quartermaster system. Thus it comes about that the first Army advisors to arrive in Country X soon perceive that their task is to determine what is needful in terms of equipment, training and reorganization to enable the host country army to meet whatever threats exist, to develop programs to this end, to persuade host country officials to accept them, and to advise and assist in their implementation. In a very real sense, therefore, if we look at it another way, the advisor's job has suddenly become one of imparting or transferring his own accumulated military skill, knowledge, and experience to one or more counterparts (whose culture he may or may not understand) to the end that their individual and organizational performance will be so improved as to obviate further need for advice and assistance.

Recent studies by the Research Analysis Corporation of the operations of the US advisory system and of US Army elements in advisory assignments have determined that a number of subjective factors operate to limit the success of the US advisor in the underdeveloped environment. But before proceeding to these subjective factors it will be useful to try to view the US advisor in a developing country as his indigenous counterparts look on him. I will quote from a RAC Study recently published entitled "Alternatives or Modifications to the Present US Advisory System."

"....the MAAG is an instrument of US foreign policy, the US advisor is not invited as a person by the host country government, nor is he paid to advise from the aspect of its own interest. He is sent by the US Government to advise the host country--to its benefit, to be sure--but in the interest of the United States. In the eyes of the senior officers and officials of the host country's ministry of defense he is not only an advisor, but also a provider of grant-aid materiel with strong convictions respecting the superiority of American manufacture whenever purchases are considered. Senior US advisors are known to go to the US Embassy regularly, together with the chiefs of other US mission agencies, to meet with the ambassador to whom they are clearly subordinate."
The difficulty to be overcome then, is that the fact that he is a member of the Country Team must not detract from, it must even reinforce, the presentation of the U.S. Advisor.

Limiting Subjective Factors

Certain illusions in the minds of US officers and NCOs seem to have become more pronounced with our emergence as a super-power since WW II. One of them is an inability to concede that the drill, tactics, staff organization or any other aspect of any foreign army is equal

to the American. A second is that non-Western peoples have the same values and behavior patterns (e.g., they appreciate a friendly pat on the back) as Americans although they tend to be contrary and lazy and must be treated as backward children. On the other hand there is a contradictory tendency to apply US standards in evaluating the performance of officers and units of underdeveloped countries. This is analagous to the tendency of the US tourist to contrast the worst he sees abroad with the best in America. If these illusions are not overcome we must inevitably project the need for the US advisory presence into the distant and unforeseeable future because it is unlikely that any developing country (Israel excepted) will ever attain US levels of proficiency. Indeed, many experienced advisors fear that the tremendous disparity that exists between rates of advancement in Western countries on the one hand and developing countries on the other inevitably dooms the latter to a fate of falling farther and farther behind the former.

The American's sense of urgency and his rigid timetable for accomplishing a specific training program are not altogether in harmony with prevailing attitudes in many tropical countries. This tends to place emphasis on mere statistics--so many people trained over such and such a period. But how well were they trained? How many trainees sat through the course, comprehending very little of what was said?

Again the more familiar relationship between officers and NCOs which now prevails in the US Army compared to 30 years ago is not characteristic of the armies of developing countries. Many officers of our active army were commissioned from OCS. Their background and level of education do not differ greatly from those of NCOs. These officers have served ably and many attain field rank. As a group they have undoubtedly modified the officer/enlisted interface, in general tending to make the behavior pattern of each group less dissimilar. There are other equalizing factors, such as the paradox of college graduates serving in the ranks under company officers with no more than a high school education, and the relatively high pay of the US enlisted man.

In most developing countries, commissions are reserved for sons of a small, educated, economically-powerful, and privileged class whereas most enlisted men are illiterate peasants. Class distinction therefore enters into the officer/enlisted relationship. The officer corps of such armies may view with irritation rather than admiration the democratic ways of the US Army. They are apt to think it odd and inconvenient that the US officer does not have a batman while noting that US enlisted men have enough money to hire native women to shine their boots and clean their living quarters and cook their meals. It has been noted by US advisors in some cases that certain indigenous officers resist receiving advice and instruction from US sergeants.

In many countries, Thailand and Vietnam among them, the officer corps also governs the country. The traditional apolitical attitude of the American officer and his non-participation in politics scarcely equip him to understand this side of his counterpart.

These limiting factors, and more,

can be included under one heading-the culture gap--which confronts the US advisor when he arrives in the country. We assume that he is professionally competent. His immediate aim, if he is to be an effective advisor, must be to establish rapport with his counterparts, the host country officers and government officials whom he is sent to advise. But when he arrives in the country he is confronted with a culture gap which varies from immense to negligible in inverse proportion to the amount and quality of cultural background he has himself acquired or the Army has given him prior to his arrival and the motivation he brings to building on that during his tour of duty.

If he was brought up as a boy in Rio because his father was in business there and married an American girl who had been brought up in Buenos Aires as is the case of a US advisor in the MILGROUP in Caracas whom I met last year, the culture gap is not very serious for him anywhere in Latin America. But this is rare. Most US advisors who are sent to the Middle East or the Far East or South Asia are unfamiliar with the country or its culture.

We tend to dwell on the language barrier as if it were the whole culture gap whereas it is only a significant aspect of it. Take a French speaking US advisor who has no prior experience of orientals, whose Vietnamese counterpart also speaks French. The fact that they can converse with each other in a third tongue without an interpreter does not go very far in helping the American bridge the culture gap--it may even contribute to misunderstanding rather than meaningful communication.

I talked recently to a US officer of field rank who was leaving for a second tour as an advisor in Thailand. He speaks Thai and is married to the daughter of a senior Thai officer. During his previous tour in Thailand he had been assigned to advise a Regimental Combat Team. He requested permission to live in quarters right in the Regimental compound. This was granted although his US superiors thought it odd that he should wish to do so. After a year he felt he had been fairly successful. He had established friendships with the Thai officers whom he advised and had succeeded in persuading them to act on much of his advice.

He was feeling altogether rather proud of himself one evening and said to his wife, "You know, I may be the most effective US advisor of my rank in Thailand--and it is because I speak the language and know and live among Thais."

She replied, "Yes, and if you live among and advise Thai officers for another 10 years you will begin to understand how they think and what they take into consideration in coming to a decision whether or not to accept and act on one of your recommendations."

The culture gap, one must infer, is wide and deep, but remember that few of our advisors anywhere but in Latin American countries can talk to the people they advise in their own tongue, and few of them even have a superficial knowledge of the history, art, literature, religion and social customs of the country.

Methods and Techniques

A variety of methods and techniques, some good, others less good, have been used by Army advisors as aids to bridging the culture gap and hurdling the language barrier. A recent Army study on US advisory operations attributed many individual and organizational advisory successes to the skillful use of the leverage that can be had through tight control of US materiel and funds needed by counterparts. Our research reveals, however, that while leverage can be an effective technique in the short run, it is counterproductive in the long run of what the advisory system hopes to accomplish simply because it coerces counterparts into accepting advice that often, in the context of their culture, their values, and the system within which they must function and achieve their advancement, runs counter to all that they know and understand. Those who advocate the leverage technique as a prime means of implementing US advice fail to take into consideration that US advisory operations world-wide are becoming less and less tied to grant aid assistance, which is the source of the leverage, and more and more tied to military assistance sales. One has only to look at Saudi Arabia which purchases not only the hardware itme that it seeks but the advisory services of its US Army mission as well, to see that Army advisors of the future will likely have little hope of exerting leverage on counterparts in seeking the acceptance and implementation of US advice.

Another technique of inferior value but one that nonetheless flows quite naturally from the American's perception of his job, is to conduct the advisory relationship on a teacher-pupil basis. In the abstract, one can hardly question that the foreign counterpart needs to learn what the American is prepared to teach. The problem is that outside of an institutional setting, the foreign officer on his home ground, within his own culture and his own military system is usually the equal if not the superior of the American advisor, and becomes resentful of any attempt by the American however well-intended it may be, to establish such a relationship. The reason for this resentment is simply that such a relationship is inherently one of superior to inferior, and the foreign officer as he appreciates himself in his own environment knows that he is not the American's inferior. One has only to look to the history of US Army advisory efforts in Laos and Vietnam to see what results when American advisors attempt to employ this technique on a large scale. Foreign officers literally drop out of programs designed to train them and their units for combat.

Against these two undesirable methods of achieving success with counterparts in the advisory relationship can be balanced two that are both desirable and effective. They are not, unfortunately, in standard use any more than, fortunately in their case, are the undesirable ones.

The first of the desirable techniques is the "split page" in which alternate lines or columns of English and the host country language are used in exchanges of correspondence, and in the publication of letters of instruction, command directives, training programs, and the like. By means of this technique, instead of having different sets of printed materials move separately through each of the American advisory and

host country Army command chains, one agreed set moves through one or the other or both chains, and at every stop along the way counterparts, even though they may not read or speak the other's language, gain visual assurance that they are reading the same document and being apprised of the same information. It is important that such assurance be had. US battalion advisors to a host country division, for example, must know when they receive a directive from the senior division advisor that their counterpart battalion commanders are being similarly ordered by the division commander. In the event, moreover, that the US communications channel should prove more responsive than the host-country's, the US advisor can compensate somewhat for the sluggishness of the host country system by proffering his counterpart an advance copy, in the counterpart's language, of what will eventually reach him through his own military channels.

The one technique which everywhere in the developing world stands out as the most conducive to fostering the kind of rapport that must be developed if advisors are to be successful, is co-location or at very best, joint location of working space. In the past two years Gen Williams and I have visited US advisory elements in numerous countries in Latin America, Africa and the Middle East, and Southeast Asia. Our observations have led us to believe that advisory success is correlative to some degree that remains undetermined to the extent that counterparts share the work areas where the business of commanding and administering a military establishment takes place. This is not to say that advisors must be integrated into the host army command structure, either individually or as units, but only that they must daily be close at hand to assist with problems and to advise on procedures, not only as they are asked to do so, but as these may come to their attention through observation; for it is oftentimes the case in developing countries that problems go unsolved for inordinately long periods simply by remaining unrecognized.

Selection of Advisors

Turning now to the second problem area that I identified earlier, the systematic program within the Army to select, train and qualify officers for advisory assignments to MAAGs requires further improvement conflicting demands on the system still sometimes result in an officer's being assigned to a MAAG largely because he is available without having volunteered for advisory duty, or for duty of any type in the country or even the region in which the MAAG is located. The historic military mission was composed of volunteers, as British Army Training Teams are today. Extra pay and various prerequisites provided by the host country were the inducements.

The Mansfield Amendment rightly put an end to vestges of similar arrangements in the old US missions in South America. It is unlikely that US officers on the active list will ever again be permitted to accept emoluments from a foreign government for advisory services. This absence of financial inducement coupled with a belief held by many officers that a tour of duty with a MAAG on an officer's record does not particularly catch the eye of promotion boards can breed dissatisifaction and discontent when an officer learns of his assignment

to a MAAG in a remote country. Frequently he attempts to have his assignment changed.

Dissatisfaction among MAAG chiefs at both the quality and qualifications of the officers sent them has not been uncommon. A general attitude prevails that improvement can and should be undertaken. No significant improvement is apt to occur unless the Department of the Army takes positive steps involving changes in personnel policies. Inducements must be created if advisory duty is to be made to attract volunteers. Steps must be taken to give the prestige and recognition to the MAAG advisor that he lacks.

As a first step and urgent need for establishing improved criteria governing the selection, training and assignment of personnel for advisory duty must be met. The new criteria should clearly reflect the importance of the advisory mission and the value of advisory service (including repetitive tours) to career development, as well as the professional qualifications and personal (to include family) attributes required to be eligible for advisory duty. With such criteria and automatic data processing, the Army could inventory its officer personnel in the appropriate grades for suitability for advisory service; institute training programs designed to qualify officers for advisory assignments; and program such assignments on the basis of qualifications rather than simple availability of personnel. Regionalization of the officer career pattern and emphasis on the Foreign Area Specialist Training (FAST) program would be a long term means of obtaining a body of advisors within the army. The concept of a special foreign advisory and training branch appears to be unsound. The development of an integrated program for systematically providing qualified advisors to the Army components of US MAAGs appears to be a task for the Office of the Deputy Chief of Staff for Personnel.

An Integrated Plan

As one looks alternately to the history of US advisory operations since World War II and to a future that seems to hold an unending series of probes by communist powers into the developing countries through the technique of subversive insurgency, one is impressed with the prospects for American mess kit manufacturers and all that this implies regarding future needs for qualified advisors. There is already a rising demand for senior field grade advisors in developing countries despite year-to-year cutbacks in Congressional appropriations for military assistance. Assuming that subversive insurgency will constitute a principal threat to Free World security in the next decade, it appears that the current system should be modified to incorporate preparation for advisory assignments into career development training with special emphasis on the academic preparation of field grade officers. The new criteria to govern selection for advisory assignments in accordance with the professional qualifications and personal traits of officers and their families should be devised in keeping with this modification. These two steps with the aid of automatic data processing, should then enable the Army to inventory its personnel for suitable advisory assets and resources that would provide a pool of trained manpower for the future.

It is extremely difficult to upgrade a special field of endeavor (military or other) which has lacked prestige unless it gains it. This can happen by chance, or be deliberately nourished, but when prestige is added there is no mistaking it; officers who have never considered the field begin to request assignments in it. The introduction of such modifications should overcome many existing deficiencies and inequities reported by personnel now serving or who have served as advisors. In combination with an area specialization career pattern, improved selection and assignment procedures should result in a general upgrading of the US Army's advisory and training effort under the MAP.

4C. HUMAN FACTORS IN THE OPERATION OF UNITED STATES MILITARY UNITS AUGMENTED WITH INDIGENOUS TROOPS

John W. McCrary
Human Resources Research Office
The George Washington University
Alexandria, Virginia 22314

INTRODUCTION

The Korean Augmentation to the United States Army, the KATUSA Program, has been in operation for seventeen years. It provides a concrete and contemporary example of the closest type of international cooperation between military forces. At the same time, it represents a long-term experiment in international partnership at the most personal level: it involves large numbers of American and Korean troops who work together in close and daily contact within their U.S. Army units. I would like to outline the concept of this program, mention some studies of it conducted by HumRRO, and discuss a few themes which help summarize some of the findings and which may have implications for the operation of binationally composed military units in other countries.

THE KATUSA PROGRAM

By means of the KATUSA Program, Korean Army enlisted personnel are assigned to units of the Eighth United States Army and are to be fully assimilated into them. They are intended to share the performance of duties, the billeting, messing, and all other unit facilities with U.S. Army personnel. The basic intent is that they be incorporated into the units as if they were American enlisted replacements. Their standard period of service, as KATUSAs, is eighteen months and their total period of required military service is 32 to 34 months. There are about 11,000 of these KATUSA personnel, or more simply KATUSAs.

The KATUSA Program has a two-fold mission:

(1) To increase the operational capability of Eighth United States Army units by augmenting the U.S. personnel in order to bring the units up to full strength.

(2) To provide training to the KATUSAs and thus increase the number of trained and technically skilled personnel available to the Korean Army or to the manpower reserves of Korea.

The importance of this two-fold mission, the economies that result from the program, and the endurance of the program suggest that the program is a success. However, it has not been without its problems or its critics as well as its accomplishments and proponents.

STUDIES OF THE KATUSA PROGRAM

The dissatisfactions of the KATUSAs were on rare occasion expressed in ways sufficiently prominent as to be publicized in the Korean press. Desiring information about the conditions giving rise to these dissatisfactions, exploratory studies of the program were conducted by HumRRO at the request of Eighth United States Army.

The first was a survey and description of the operation of the program based on study of policies and regulations, field observations, and interviews with American and Korean personnel.

The apparent importance of and lack of reliable information about intergroup and interpersonal factors led to the second of the two studies. It may be characterized as an attitudinal-informational study using questionnaires designed to obtain reports from the KATUSA and American enlisted personnel concerning their expectations of the program, their attitudes and opinions about various conditions within the KATUSA program, and their associations with and attitudes toward one another. Over 400 KATUSAs were asked over 250 questions and over 400 Americans were asked over 200 questions.

My discussion today is based upon incomplete analyses and tentative interpretations of a part of the data and upon intermediate impressions formed while joining my more informal observations with the responses to some of the questionnaire items. I have selected a few overlapping <u>themes</u> which help summarize some of my tentative interpretations and which emphasize those most human of the human factors likely to characterize any augmentation program.

THEMATIC SUMMARY OF FINDINGS

<u>Created Differences</u>

Certainly in a program of this sort, there will be differences contributed by the manpower resources available for selection. The personnel can be expected to bring with them differences in language, skills, socioculturally determined norms and behaviors, or physical size and appearance.

While these differences can be very important, I want to call particular attention to <u>created differences</u>, that is, those differences brought about by the implementation of agreements and decisions about administrative and disciplinary matters (from pay and promotion to court-martial jurisdiction), about support and recreation matters (from billeting and messing, clothing and laundry, medical and dental, to unit and special services activities, army theaters and exchange facilities) and about duties (including job assignments and assignment to details). There can be an almost unlimited number of these differences, but my informal observations and interviews lead me to conclude that where there is any difference, it is a potential source of discontent, complaint and dissatisfaction.

The low pay of the KATUSAs (as of early 1967, a corporal was getting about $1.33 a month) is a basic problem with many implications but does cause the KATUSA to be especially dependent upon arrangements for his support and tends to magnify otherwise not-so-

important differences. Additionally, the KATUSA's most obvious and immediate frame of reference and comparison is what Americans are provided (or are able to provide for themselves) rather than what he would have had if he had served with a Korean unit. Thus, taking even the greatest care to provide for the essential needs of the KATUSAs does not necessarily result in their complete satisfaction. Despite having been given three meals a day, the KATUSA may feel that additional support is needed if he is watching his American co-worker enjoy a hamburger and shake sent over from the snack bar. On the other hand, he may be less impressed by getting into the Army theater free of charge than by having to wait outside until all paying customers have been seated.

These limited illustrations emphasize the difficulty of anticipating and satisfactorily resolving dissatisfactions created by differences. Nonetheless, wherever there is a difference between whatever is provided for the two groups, it is likely to be responded to and may form the basis for discontent and complaints.

Attitudes as By-Products

There are attitudinal by-products to be expected in an augmentation program. These result from the interpersonal and intergroup interactions of participants in the program.

For example, offered choices ranging from extreme liking to extreme dislike, about 56% of all the KATUSAs indicated some degree or extent of like for the American soldiers while 44% expressed some degree of dislike. Thus, for the KATUSAs as a group, a simple majority does indicate liking the American soldiers, but these expressions fall considerably short of unanimity. This lack of unanimity helps us to understand why opinions about and impressions of the KATUSAs attitude about Americans often tended to be conflicting.

In comparison, 84% of them reported some degree of liking and 16% reported some degree of dislike for their fellow KATUSAs. Thus, while more KATUSAs reported liking than reported dislike for the Americans, more of them expressed liking for their fellow KATUSAs.

Time and Attitudes

There is evidence that these attitudes change over time. If we sort out the KATUSAs on the basis of the number of months they have served as KATUSAs, we observe significant differences in the average extents of favorability or liking of Americans that are reported. The attitudes of the Koreans who have been KATUSAs for about a month or less are the most favorable while the attitudes of the KATUSAs who have been in the program from six months to one year are the least favorable. Those who have served as KATUSAs for a year or more show more favorable attitudes than those in the middle ranges of their tours, but still respond less favorably than those who are beginning their tours. The relationship between attitudes toward Americans and length of service as a KATUSA is, thus, somewhat bowl-shaped, but the bowl is tilted and the net effect is, thus, a loss in favorability. There are many conjectures to be offered for the

way in which the attitudes toward Americans undergo overall decline and yet vary in this bowl-shaped fashion. The disappointment of early expectations, the difficulties in interacting with Americans, and then working out a way of getting along with them without so many problems, may all be meaningful ways of looking at the phenomenon. The attitudes of the KATUSAs toward the Americans are not fixed and static, but undergo changes that may be reflecting disappointment of original expectations of the program and disappointing experiences with Americans.

Units and Attitudes

There is considerable variability from unit to unit in the attitudes of the KATUSAs toward the Americans, even when we compare seemingly similar units. Let me select one example. Units A and B are "sister" batallions of the same organization with similar missions, organizations, job structures, and low proportions of KATUSAs. However, significantly larger proportions of the KATUSAs in Unit A, compared to Unit B, report that they like the American soldiers (74% vs. 39%), that they like their fellow KATUSAs (97% vs. 65%), and that they are proud to be members of their unit (74% vs. 45%). Clearly, the attitudes of KATUSAs are influenced by circumstances within the unit.

The Favorability Gap

Let me turn your attention to a consideration of the attitudes of the Americans and introduce a complex phenomenon which I will refer to as the favorability gap.

Asked how they felt about the KATUSAs and offered answers ranging from extreme dislike to extreme liking, about 60% of the Americans reported some extent of liking and about 40% reported some extent of dislike. Asked how they felt about their fellow American soldiers, 94% of them reported some extent of liking and only 6% reported some extent of dislike.

Comparison of these responses shows that, while the Americans as a group indicated liking for the KATUSAs somewhat more often than disliking, they much more often express liking, and greater degrees of liking, for their fellow American soldiers. The difference is large enough to merit special attention and interpretation. It can be suggested that the much greater probability that the American will report liking, and a greater extent of liking, for his fellow American soldiers reflects a relative or comparative dislike of the KATUSA. The American is more likely to evaluate favorably his fellow American soldiers, hence, we may speak of a favorability gap.

There is no reason to doubt the American who says he likes KATUSAs, but there is good reason to compare how he feels about Americans and to consider what he may do when confronted with decisions and choices involving Americans and KATUSAs. While it is important to have some idea about what the KATUSA will hear, it may be even more important to have some idea about what he will see. It is quite possible that the favorability gap becomes very apparent to the KATUSA after some experience in interacting with the Americans in his unit.

It is interesting to note that smaller American favorability gaps

tend to be found in those units with smaller percentages of KATUSAs (15-20%) and larger gaps tend to be found in those units with larger percentages of KATUSAs (50% or more). This finding is in keeping with the hypothesis that in the higher KATUSA density units (units with large percentages of KATUSAs) greater competition for the available facilities (particularly recreational) would tend to affect interpersonal attitudes. There is the somewhat more conjectural, but perhaps more meaningful, possibility that where KATUSAs are present in larger proportions they will not only be more prominent because of their numbers but that they will also "act even less like Americans." They may be controlled more by each other and act more in accordance with Korean norms than they would in a unit with smaller percentages of KATUSAs Thus, the larger favorability gaps may reflect reactions not merely to numbers but also to a KATUSA who behaves in ways that differ from his counterparts in low KATUSA density units.

At the same time, the KATUSAs in these units are faced with Americans whose evaluations of KATUSAs compared to Americans differ from the evaluations faced by their counterparts in low KATUSA density units. To the extent that the Americans' favorability gap is apparent to the KATUSA or influences decisions which involve him, we find a possible chain of circumstances and events capable of accentuating intergroup problems in the high KATUSA density units.

SUMMARY AND IMPLICATIONS

We have considered a few themes which help summarize portions of the data from studies of the KATUSA program. What do they tell us about the establishment of programs of this type in other areas?

The institution of an augmentation program which creates binational U.S. Army units involves, first of all, decisions about many matters ranging through selection and assignment, administration and discipline, command and supervision, training, and a wide variety of support problems, such as billeting and messing, clothing and laundry, medical and dental, recreation and morale, etc.

While decisions about many of these matters can be simple and straight-forward depending upon particular local conditions, others may have to be in the form of compromises because of complex and possible conflicting requirements, resources and conditions. It would seem very obvious, yet it would be a most lengthy task, to point out the human factors elements that enter into virtually each and every one of these decisions.

Determining the essential needs of the other national personnel and then taking care of these needs may, however, be insufficient. What may be important is any difference between what the two national groups are provided.

Additionally, since augmentation programs may bring sizeable groups from differing sociocultural backgrounds into important, close and daily contact with each other, they can be expected to generate interpersonal and intergroup relationships and attitudes that are important because

(1) most generally, they may constitute an important

part of the local nationals' assessments of Americans and American ways of reacting to other people, and

(2) most specifically, they have important implications for the effective operation of augmented units.

There will be attitudinal by-products of the program. The by-products will be importantly influenced by experience with the Americans and conditions within the units. The most common reason given by KATUSAs for wanting to be a KATUSA was "to meet and learn about Americans." Those concerned with implementing augmentation programs might well try to take such motivation into account and keep in mind the question, "What are these people learning about Americans?"

The implications of an American favorability gap may also be considered. While the average American in such a program may accept (at least somewhat) and like (at least somewhat) the other national soldiers, the chances are that he will be much more accepting and favorable toward his fellow American soldiers. Thus, we have not only another kind of difference to which the other national may be sensitive, but we have a potential source of additional differences that may range from who is invited to join the crowd to who is invited to clean the grease trap on KP.

The implications that have been suggested may seem discouraging. The intent here is to show them as challenges.

Aware of the challenges, Eighth United States Army has been engaged in continued staff efforts and places important command emphasis on the leadership at all levels to improve the operation of the KATUSA Program.

Recent measures have included a number of changes designed to reduce to the lowest practicable level several of the important differences in the areas of logistic support, recreation, and welfare. New staff positions have been created in Eighth Army Headquarters with responsibility for making staff visits, assisting units in the conduct of the program, and the supervision and conduct of recently instituted programs of orientation and attitudinal change designed to insure constructive relations between KATUSAs and Americans.

The KATUSA Program has been characterized as a long term experiment in the closest kind of international and intergroup cooperation. Studying the KATUSA Program can suggest some of the challenges posed by human factors in the operation of augmentation programs. There is a Korean expression, "Even a jewel becomes brighter with polishing." An important ingredient in the success of augmentation programs may be the attitude reflected in Eighth Army's continued determination to make a good thing better.

4D. MILITARY ASSISTANCE – CARGO OR CONCEPTS

William K. Carr
Center for Research in Social Systems
The American University
Washington, D.C. 20016

International aid-and-advice programs automatically undergo unpredictable modification by the recipients. Assumptions made by the programs' designers do not coincide with those held in the foreign society. To train recipients in the use and care of equipment, or in procedures of administration, does not prevent the acculturation of foreign aid programs. The current U.S. Military Assistance Advisory programs furnish numerous excellent examples of this acculturation process. Although many members of both cultural groups are bilingual, and although thousands of the foreign Army officers and men have been trained in U.S. military technical schools, there are constant differences in interpretations of methods and goals.

To illustrate the way Americans generally see the problem, a few of the most frequently heard complaints are listed below. Situations to which these complaints refer will be interpreted in terms of non-American social values. As reports from one foreign country duplicate the problems voiced for others, it may be assumed that we shall be discussing a generalized situation. I must point out that I am not concerned with whether the Americans' complaints are justified, nor whether they result from some form of American parochialism. In the belief that neither the Americans nor any other people can change their respective views of life, my comments will be directed at possible changes in the procedures of international cooperative programs. "Improvement of human performance in overseas operations" may be achieved sooner by operational changes than by cultural changes.

It should be kept in mind that the very nature of aid and advisory missions seeks to bring about changes in both thought and action in the society receiving the aid and advice. Such changes are universally resisted.

Some of the typical American comments about working in non-western societies are repeated here.

1. Non-westerners don't benefit from technical training. They never seem to learn to construct or to repair modern equipment. Machines are used until they become inoperative, and then a request for replacement is sent to the sponsoring U.S. agency.

2. Foreign officials don't

adhere to c[illegible]tional structures i[illegible] the performance of operations, and it is very difficult to determine the line of responsibility.

3. Cooperation between the local organizations themselves is very rare, which further handicaps the U.S. agencies having a joint effort with more than one department.

4. The foreign counter-parts will accept an agreement in a face-to-face meeting, but will often ignore it afterwards; many times they will deny ever having made the agreement.

5. They seldom carry out a task or program according to specifications; they are satisfied with an approximation and, of course, in such matters as the operation of complex equipment such an attitude is crippling.

6. In public, the local inhabitants often stare and point at foreigners, but in personal relationships with foreigners they are polite and amenable. This creates in the American a feeling that the natives are hypocrites.

As these complaints are expressions of frustrations, they are naturally stated as universalities, without exceptions. Even the exasperated American would admit, on second thought, that the foreigner's behavior is not quite so consistent as he portrayed it. In the matter of building and maintaining complex machinery, for example, there are many instances from textile mills to nuclear physics which show competence. It is not at this level of technology, however, that aid missions operate. I am not talking about what certain individuals in non-western societies can do; I am talking about what the non-westerners normally do. Normally, inoperative western-style equipment is left inoperative; or, if it is supplied by a foreign aid mission, the mission is asked for new replacements.

The Asian and African uses of formal organizational structures is a little too complex to characterize quickly, but the American's bewilderment in this question seems to come mainly from the lack of coincidence between those individuals officially designated to perform certain tasks and the individuals who actually perform the tasks. A similar situation exists in many American organizations; but when we go overseas, we take our ideals, not our behavior.

Americans are continually annoyed by the foreigner's failure to live up to the terms and specifications of agreements. Our criticisms are of two kinds. We claim that a promise is often repudiated to the extent that it was never made. In other cases, the agreement is so drastically modified that it no longer accomplishes its original purpose. We accuse the aid recipient of being more interested in playing the game of cementing personal relations than in being interested in getting a job done.

The discrepancy between public and private behavior towards foreigners, is really the starting point for attempting to explain the behavior Americans find inexplicable. If there is one basic trait

of non-western society, it must surely be the division made between strangers and friends. Strangers, whether foreign or native, are of an impersonal character. Friends, whether foreign or native, are partners in a binding, reciprocal obligation relationship. There is a middle category which we would call "acquaintances." Foreigners are usually in this class. It is towards these middle-ground people that the native is "polite," that is, from whom he keeps his distance. Empty promises are made as a matter of form. No one should expect them to be honored.

The other type of agreement-breaking in which specifications are modified beyond recognition is caused, in some cases, by indifference to details. Asians are often more concerned with using the job-at-hand as an opportunity to activate their mutual-obligation relationships. This importance of inter-personal connections and the corresponding lack of interest in persons not involved in the network, would seem to underlie the rather cool public treatment of foreigners and the alleged propensity for nepotism and "kickbacks" in financial transactions.

It is not my purpose to present a detailed and convincing argument of why non-westerners behave as they do. The list of complaints Americans have about working with these peoples, and the brief interpretation of related behavior, serve merely to illustrate one aspect of overseas operations in which human performance could be greatly improved. The method I am suggesting involves tailoring the form and procedures of international operations to fit the sociological environment in which they are to be conducted. This method, therefore, accepts the American dislike of certain traits in foreign behavior. By admitting to ourselves that friction exists, and by using our knowledge of foreign societies, it seems possible to devise a system for designing more effective programs.

I see the problem in engineering terms. There are factors and variables that are fixed, and the desired system must take these into account. In this case, I am not advocating that we Americans conduct our operations according to other nations' rules; to do so would be a contradiction in terms. If something did not need changing, we would not have aid and advisory programs. By the same token, I am not suggesting that we force the other fellow to do it our way, which, in any case, he cannot. All I am saying is that we should acknowledge the specific differences between the two patterns of behavior as fixed constants, and so construct our overseas cooperative programs that they will be compatible with the constraints imposed by both social systems.

An example will illustrate what I have in mind. In the United States, we have the practice of competitive bidding for government contracts. To us, this seems fair to all interested parties. It is also a way of regulating costs. Competitive bidding is rendered meaningless in those countries in which there are no laws against collusion, and in which no manufacturer is self-sufficient enough to take on a contract without first getting his colleagues involved. We may not like the idea of the contractor employing his friends and relatives, but this is the only way he can exert control over the performance of the contract. We

could, however, guarantee reasonable costs and satisfactory results by taking the time to negotiate thoroughly beforehand, and by exerting personal and direct pressure on the prime contractor. This would be a compromise. We would give up the impersonal, legalistic procedure of competitive bidding, and the contractor would give up the freedom to redefine the contract as he sees fit. Asians may not like to be closely supervised, but they will tolerate it. We do not like to spend time strengthening personal relations, but we have the ability to do so.

If this example does not seem to indicate the necessity for any substantial modification in the form of our overseas efforts, let me remind you that good personal relations in most of the Eastern Hemisphere entails not only a seemingly endless amount of time, it also requires, e.g., many large dinners and a constant flow of small favors. In addition to our native dislike for giving of our time, we administratively prohibit ourselves from spending more than a minimal amount of time developing social contacts. No American manager would permit his subordinates this freedom; no American budget officer would authorize the attendant expenditures.

It would take a good deal of reorganizing on our part to change the institutional form of our overseas operations, but we have the knowledge to do so. If done successfully, the goals we set up would be more realistic and, therefore, more often achieved.

4E. CRITERIA FOR EVALUATION OF CRITICAL PSYCHOLOGICAL OPERATIONS MANAGERIAL FUNCTIONS

James M. Dodson, M. Dean Havron
and Carl F. Rosenthal
Human Sciences Research, Incorporated
McLean, Virginia 22101

Most material on psy ops takes the view of a planner operator attempting to "sell" a particular theme, idea, or message to an audience. This view must be amplified by organizational concepts for assessing and then improving the psy ops organization which commonly carries out a variety of concurrent missions and programs.

A managerial, or systems concept views psy ops as an interlocking chain of plans, actions, and events culminating in desired changes in the attitudes or actions of the audience. Systems analysis methods may be employed to identify the activities or functional links in this chain. We have divided the cascading chain of actions and events constituting the psy ops process into three broad classes of functions: management, operations of media, and audience response. This presentation will focus solely on the management function; it will:

1. Delineate the management functions that must be performed by a self-sufficient psy ops unit.

2. Present illustrative criteria for estimating how well the functions are performed.

3. Discuss the management of psy ops in RVN.

4. Suggest ways that the management of psy ops in RVN might be improved.

The discussions and criteria which follow are oriented toward the management of psy ops in RVN. Discussions and criteria are predicated on the assumption that a self-sufficient psy ops unit needs to be able to perform or have performed for it, certain essential functions. These functions can be made explicit and the effectiveness with which they are performed can be evaluated in terms of appropriate criteria. Functions are described below, then criteria for evaluation of each. Criteria are presented as questions. While performance of these functions does not guarantee psy ops impact, lack of capability and/or failure to perform major functions will very probably reduce psy ops effectiveness.

The functions are as follows.

1. Doctrine and policy formulation function -- doctrine and policy (usually formulated by the superior unit) should provide clear

objectives, provide guidance for the implementation of these objectives, and clarify responsibilities between major agencies.

2. Planning function -- planning which is consistent with the aims and objectives set at higher levels must insure the efficient allocation of resources in terms of priorities and capabilities of the unit.

3. Information function -- means must be established for the procurement, flow, storage, and retrieval of information about media, audiences, etc. which a psy ops unit or organization requires for the conduct of its operations.

4. Audience analysis function -- detailed analysis of intended audiences is required to develop themes, appeals and to select proper media.

5. Pre-testing function -- alternation themes, appeals, and messages must be evaluated prior to their dissemination.

6. Production and dissemination of functions.

7. Post-testing function -- methods must be established for measuring the effects of psy ops communications on audience attitudes and actions (behavior).

8. Organization effectiveness and personnel capabilities.

A special section focuses on criteria for U.S./ARVN military elements pertaining to the psychological impact of troop behavior and considerations in the use of military forces.

Certain reservations/qualifications should be noted:

1. We are still learning what is needed for psy ops in an intensive counterinsurgency contest. The statement of functions represents our best present approximation of functions required. Descriptions and criteria can still stand improvement. Use of these criteria for evaluation purposes will help clarify and delineate certain of the functions still further.

2. These functions pertain basically to those required of a self-sufficient psy ops unit, specifically a psy ops company or battalion. They can provide guidance for evaluation of other groups assigned psy ops responsibilities (psy ops in MACCORDS, Army Divisions), but appropriate modifications in statements of functions must be made first. Criteria would then be derived from these statements of functions.

3. Some further work is needed before application of these criteria, including:

a. Development of instructions for evaluation. Certain of the functions described are readily evaluated; no instructions are needed. Instructions are needed for evaluation of other functions -- what to look for and how to combine observations.

b. Development of a system of scoring these criteria so that each item can be scored and item scores for each function can be summed.

1. Adequacy of Psy Ops Doctrine and Policy

Doctrine and policy establish psy ops strategy and, to some extent, tactics. Although general doctrine for psy ops can be obtained from

field manuals and relevant military publications, doctrine for operations in a particular country will normally be formulated and distributed by the superior unit. In addition to stating objectives, doctrine and policy should provide guidance for their implementation; clarify responsibilities between major agencies; serve as a basis for "position papers" to third nations.

Since local conditions vary greatly from sector to sector, general doctrine may not be sufficient to encompass every exigency. Hence, doctrine should be sufficiently flexible to enable tailoring objectives to operational requirements, local conditions and responsibilities.

1. Is there joint collaboration between the allied forces in the formulation of psy ops policy and doctrine?

2. Is there adequate internal coordination of psy ops policy between U.S. agencies, civilian and military?

3. What is the source of local and national psy ops policy for the psy ops unit? For the psy ops advisor?

4. Are policy objectives clearly delineated and easily comprehensible?

5. Do doctrine and policy provide useful and positive guides for the conduct of psy ops at the local level?

6. Are doctrine and policy material made available to all key psy ops personnel throughout the chain of command?

7. Are changes in doctrine clearly and rapidly transmitted to all subordinate units or groups?

8. Does unit doctrine specify a catalog of themes and appeals and indicate the circumstances and conditions for their use?

<u>2. Adequacy of Planning</u>

Higher level doctrine and policy provide the basis for the strategy, tactics, and plans of subordinate psy ops units. Because of the nature of the Vietnam conflict which involves a series of little wars each possessing its own characteristics and unique psy ops requirements, psy ops planning requires decentralization consistent with aims and objectives set forth at the higher level. Hence, subordinate psy ops units have a substantial planning function to perform. The primary role of planning is to insure the most efficient allocation of resources in terms of priorities and capabilities. Criteria for evaluation of planning within the total psy ops spectrum will be based on the assumption of compatibility of psy ops aims and objectives at higher levels, allocation of resources and flexibility to satisfy changes in mission and situation.

1. Are plans consistent with the overall doctrine and policy which they support and are they consistent with existing priorities set by doctrine and policy?

2. Are the plans realistic in terms of the resources and time available?

3. Are the plans flexible enough to adjust to the rapidly changing situations characteristic of the conflict?

4. Do the plans provide adequate coverage/direction for the use of resources of psy ops units?

5. Do the plans provide guides for assisting commanders in planning the use of their military forces?

6. Are plans periodically reviewed at all levels to ensure compatibility?

3. Procurement, Flow and Storage of Information

The procurement, flow and storage of information to be used by the psy ops unit or agency may be divided into five major functions:

Specification of Information Requirements. General and specific information requirements (e.g., vulnerabilities, Montagnard values, etc.) should be delineated and priority should be established for procuring the information needed by the unit. These requirements will be predicated upon the general psy ops mission and anticipated specific missions for which the psy ops unit (agency) is responsible. The types of information needed for existing psy ops programs and anticipated or probable programs should be specified and cognizant civilian sources such as CRESS (Center for Research in Social Systems) should be apprised of these information requirements.

Procurement of Information. Actual plans should be made for levying information requirements on private research agencies which generate information of value for psy ops. Channels should be opened and maintained between these civilian research agencies as well as G-2/S-2 information sources.

Filtering of Information. Once the information is received, it must be filtered (screened) for relevance to psy ops existing and anticipated operational needs. If information is not filtered in terms of the operational information needs of the psy ops unit, a great deal of useless information will wastefully burden the coding, filing system.

Storage and Retrieval. Provisions must be made once the information has been filtered for relevance and classified (coded) for storing the information and developing a system for retrieving appropriate information. If the information is to be held in a library system, appropriate library techniques and procedures may be established.

Information Output. Information distributed to subordinate units may be in a raw form or may have been previously processed before distribution. To avoid overburdening and perhaps confusing the unit, it is essential that the output be specifically geared to the needs of the requesting organization.

Criteria. Criteria are presented below for each of the five functions. A set of criteria is also presented for assessing the adequacy of the information personnel capability.

a. Information Requirements.

1. Are information requirements predicated upon the general mission and anticipated specific missions delineated? Are certain critical information requirements, such as the need for vulnerability information on a particular audience, clearly specified?

2. Are information requirements prepared at the corps, division, province, and sector levels?

3. Are present requirements adequate in terms of the demands of present and anticipated psy ops programs?

b. Procurement. Describe the information procurement process.

1. Are the general information requirements, including critical needs, specific procurement requirements, and collection guides given to procurement agencies and personnel?

2. Are procurement plans readily available to cognizant collection agencies and personnel?

3. Are standardized information collection formats utilized in the procurement process?

4. Are the collectors aware of all available sources producing the desired information?

5. Are channels open to collection agencies other than G-2/S-2 such as CRESS? Are these channels used? How frequently are they used?

6. Do procurement agencies and personnel rapidly disseminate needed information to corps, division, province/sector agencies and units?

c. Filtering.

1. Input - Describe the input process:

(a) What is the actual size of the input?

(b) What are the criteria for selection of what is to be held or stored in the system?

(c) Is the screened information compatible with the information requriements?

2. Coding - Describe coding methods and procedures:

(a) Is a systematic coding procedure used?

(b) Are coding classification manuals available and used?

(c) Are coding procedures compatible with the latest advancements in coding techniques?

(d) Are vulnerabilities for specific audiences coded?

3. Indexing - Describe the methods used for indexing:

(a) Are indexing procedures compatible with recent developments in indexing techniques?

(b) Are the indexers trained in the use of these new techniques?

d. Storage and Retrieval System (Library System).

1. Describe the storage and retrieval system including the kind and number of items in the system. If a library exists, describe its facilities, number of books, kinds of materials available, methods of obtaining materials.

(a) Does the library contain: 1) catalogues of psy ops appeals; 2) document translations; 3) information reports; 4) field reports; 5) National Intelligence Survey sections; 6) recent books, monographs on Vietnamese culture, psychological operations, etc.?

(b) Are physical facilities adequate for the storage of information?

(c) Is the adequacy of the system tested by submitting a list of demands or prepared questions to it?

(d) Is the system capable of satisfying specific questions on vulnerability types, media preferences, key communicators, etc.?

(e) Do psy operators with specific requests have quick access to the retrieval or library system? What are the procedures involved in obtaining materials?

(f) Are the output levels and speed of output adequate to meet the volume of demands levied on the retrieval system? Is the system satisfying present demands placed upon it?

e. Information Output.

1. Are requests for information frequently made by subordinate psy ops units?

2. Is the information previously processed or sent in original form to the subordinate unit?

3. Is the information rapidly transmitted to subordinate unit requestors?

f. Personnel.

1. Are personnel functions for procurement, filtering, storage, and retrieval clearly defined and described?

2. Are unit personnel performing the functions specified in the TO?

3. Are personnel assigned on a full-time basis to collection, screening, coding, indexing, etc.? If not, how many man-hours are assigned to each of the information functions?

4. Are the personnel trained in the latest techniques of screening, coding, and indexing?

4. Audience Analysis for Theme Generation and Media Selection

The cultural characteristics and technical resources of the target have implications for the selection of media as well as for the content of messages. To determine the most credible means for the presentation of a message requires development of information about the audience. Examples of information requirements are listed below. See Chapter II on Audience Vulnerabilities.

Language and Literacy. Improper use of the language can reduce credibility and the desire to attend to media. Literacy level of the audience may determine which media are appropriate. About half or more adult Vietnamese are literate. However, there are considerable differences in literacy levels, vocabulary and idiom between urban and rural areas and between Corps areas. These differences must be developed via audience analysis.

Religion; Traditions. Messages which violate the cultural sensitivities of an audience may stigmatize both the communication and the mode of communication. Leaflets, for example, displaying taboo symbols may undermine the credibility of all leaflets intended for constructive purposes. Information about religious beliefs of indigenous groups should be developed via audience analysis. This pertains to the Catholics, Buddhists, Cao Dai, Hao Hoa and the various animistic cults of the Montagnards.

Social Structure. Even in the smallest communities, there are differences in values, attitudes, and sentiments clustering around groupings based on age, sex and occupation. Accordingly, different groupings have different interests

and different patterns of media preference. Thus, the radio preferences of the old might be significantly different from those of the youthful. Certain occupational groups, particularly the professional, seek out specialized media in preference to the mass media. Also, the work patterns of an occupation may delimit the periods when an individual is exposed (or can expose himself) to certain media. The characteristics of local groups, including those with greatest power, should be known and periodically reanalyzed.

Key Communicators and Opinion Leaders. Even in remotely situated villages, there is usually some contact with the outside world. Identification of these intervillage channels can enable the psy operator to reach groups otherwise inaccessible or enhanced the level of information saturation of accessible groups. Penetration is achieved through directing information toward influential itinerants such as bus and cab drivers, craftsmen and peddlers. Information about these itinerants should be available to the psy ops unit.

A central target for psy ops in RVN are key opinion leaders. In the countryside especially, hamlet and village chiefs and local religious leaders wield a great deal of power. These individuals, who might be viewed as secondary media, serve as important modes of communication. Because of the tendency by the community to readily endorse the conclusions of these individuals, a primary responsibility of audience analysis is to identify these persons, to determine how they form their opinions and what media they attend to. If the opinion leaders of the community can be effectively reached, the communicator has developed sources of prestige and credibility to serve as a conduit for the transmission of propaganda.

Physical Assessibility and Technical Resources of the Target. Because different targets have varying degrees of accessibility to media, existing circumstances require different modes of communication. The Audience Analysis function is to determine which audiences are accessible to which media. This information needs to be up-dated as parts of the population move and as new media are introduced.

As the management level, the following criteria should be considered in relation to key targets to rate the adequacy of information currently available:

1. Is there adequate information about the target's notion of "correct language"? Is the prose of the message in accord with the ing language" of the recipients?

- vocabulary (paucity or richness)
- grammar (lexical elements, word structure)
- stylistics (conversational, narrative, rhetorical)
- semantics
- special languages (marginal languages such as pidgin, trade languages, and languages confined to a particular sex, occupation, social class or ethnic group)

2. Is there information on technical barriers to media receptions, such as lack of radio receivers?

3. Since different media, like different occupations, are afforded varying levels of prestige, is there adequate information on those sources which are held in highest

esteem? Is there information about media held in low esteem?

4. Is there information about the periods (holidays, leisure hours) when a target is most physically accessible and psychologically receptive to different media?

5. Is the media and message in accord with the preferred reading and listening habits of the audience? Is there available, adequate, reliable, and up-to-date information on:

. the degree of audience interest in war news, home front news, wired news, spot news, feature and background stories, sports events, etc.?

. audience standards of credibility (information in accord with the perceived facts and experiences of the audience?

. the types of situations and people with which the target most readily identifies?

. the production standards necessary to capture the attendtion of the audience (for example, for posters: size of lettering, colors, photographs, illustrations, maps)?

. the peak listening hours for radio (by age, sex, and occupation)?

. the places where printed matter, radio are most normally attended (home, community center, bulletin board, etc.)?

. the programs, publications, stories, dramatic situations most popular with th audience?

. the programs, publications, stories most frequently discussed and the places and people with whom discussion takes place?

6. Is there adequate and up-to-date information on roads, sites where target frequently traverses and/or congregates (suitability for placards, leaflet drops, etc.)?

7. Is there adequate information on communication channels which exist between the target and the outside world?

. What percentage of the people get information from outside the hamlet by various communication modes?

. What are these modes?

. How frequently are they used?

8. Is there information on informal communication channels and influences which exist <u>within</u> the local communities?

. Are key communicators identified (by age, sex, and occupation)?

. Are opinion leaders identified (by age, sex, and occupation)?

. Are their media-attending habits known?

5. Pre-Testing Facilities and Procedures

Pre-testing of alternative themes and appeals for their relative worth and probable impact prior to dissemination is a critical part of the evaluation process. Pre-testing requires submission of themes/appeals to panels composed of members of the audience to which they will be transmitted or to a panel composed of members "most like" the target audience. The panel will thus be a simulation of the real audience. The purpose of pre-testing is to evaluate the alternative themes/appeals in terms of their:

a. Understandability
b. Saliency/attractiveness
c. Logic
d. Semantical structure, use of idiom, vernacular
e. Format
f. Credibility

Although pre-testing is time-consuming, the greater effectiveness of the materials produced should justify the expenditure. When a quick response is desired, however, pre-testing may be too time-consuming to be applicable.

Psy Ops Personnel Capabilities for Pre-Testing.

1. What is the number of personnel actively involved in pre-testing?

2. How many man-hours per month or per quarter are devoted to pre-testing by each person?

3. What functions are performed by the personnel?

4. What are the qualifications of the personnel involved in pre-testing, including the type and amount of training they receive?

Adequacy of Pre-Test Procedures. Describe the pre-testing procedures including:

1. Panel selection and composition.

2. Procedures for instructions, use and interrogation of panel.

3. Does the pre-test cover:

a. Understandability of themes, appeals, messages?
b. Saliency of themes, appeals?
c. Credibility of themes/appeals/messages.
d. Identified source of themes, appeals, messages?
e. Logic of argument in view of beliefs and values of intended audience?
f. Language/Literacy level of themes/appeals/messages compared to that of the intended audience?
g. Use of idiom, vernacular -- related to those of the intended audience?
h. Form of presentation (pictorial display, colors), formats for other media?
i. Media preferences and listening/attending habits of the audience?

4. Describe the data collection and data processing procedures in the pre-test process. Are:

a. adequate samples made?
b. appropriate methods, involving systematic use of statistics used to synthesize the data?
c. summary records of pre-tests kept?
d. pre-test findings fed back to lateral and higher agencies for incorporation into the psy ops process for improvement of themes, appeals, messages?

Note. The same procedures will be followed whether new material is being generated by the unit, or material developed elsewhere is being pretested. In either case, pre-test records including summary statistics and tests of significance should be available for review.

6. Capabilities for the Production and Dissemination of Propaganda

The psy ops unit's media resources should be sufficient to accomplish its mission. This will include the more popular media or access to them, production facilities and technical expertise (or ready access to

agencies with these capabilities) to design messages and utilize media in the way which will satisfy the target's standards of cogency and credibility. In light of audience analysis, the following hardware and software criteria should be considered:

1. Does the unit have at its disposal a sufficient array of media resources? Indicate the frequency with which each of the following medium is normally resorted to (per week, month) in the performance of propaganda missions.

Mission	Very Frequently	Frequently	Infrequently
Leaflets			
Newspapers			
Books, Journals, Magazines			
Placarded			
Radio and Television			
Loudspeakers			
Motion Pictures			
Cultural Productions			
Face-toFace Communications			

2. Are there adequate technical facitlties for the production of different kinds of printed matter (adequate supplies of paper, ink, presses, type, laboratory facilities)?

3. Are there adequate technical facilities for audio and audiovisual production (studio space, technical equipment, mobile broadcasting units)?

4. Are there adequate stockpiles of spare parts and supplies?

5. Are there sufficient numbers of skilled personnel able to effectively undertake all the unit s missions (competent editors, broadcasters, technicians, artists)?

6. Are there services outside the unit readily available to support, when required, the unit's missions?

7. Are there adequate facilities for the dissemination of information (range of braodcasting signal, availability of land, sea, air facilities for transportation of printed matter)?

8. Are records faithfully kept to insure that messages are timely and consistent with one another (designation of leaflet message by serial number, number and types of films shown in target area, record of time devoted to and message content of informational broadcasts)?

7. Post-Testing.

Another function of the psy ops R and A unit should be the measurement of effect of communications. The ultimate criterion is that psy ops have audience impact. Post-testing of psy ops communications is required to measure this impact in terms of changes in attitudes and behavior over time. The difficulty and complexity of measurement of impact will depend on factors such as the nature of the request made of the audience, the accessibility of the audience, and circumstances external to the communication which may change attitudes and behavior. This task is often time-consuming. In some cases, post-testing will be beyond the competence of regular psy ops personnel. Under such circumstances, it is advantageous to enlist the assistance of qualified researchers.

Criteria

1. What facilities, personnel, capabilities does the unit (agency) have to measure impact?

2. What areas of social behavior are considered crucial in the measurement of audience response?

3. Does the study design of measurement of audience response include:

a. a statement of objectives?

b. specification of the behavior to be measured?

c. valid, reliable, and practical measures of audience impact?

d. sampling procedures which are adequate?

e. adequate statistical, experimental controls?

f. adequate measures of type, amount, and duration of psy ops effort?

g. data integration methods and procedures?

h. adequate methods for associating communications and criteria?

4. Are results distributed to all interested agencies throughout the chain of command?

8. Organization of Psychological Operations Unit or Group and Personnel Capability

The organization of the psy ops unit or group should facilitate efficient and coordinate performance of missions. In terms of human factors, personnel assignments within the organization should be made in accordance with job requirements. If the requisite skilled personnel are not available to the unit, arrangements should be made to obtain assistance from elsewhere.

Organizational Capability.

1. What is the form of the unit organization? Is the area of operation clearly defined?

2. Does the psy ops unit adequately support the missions of its parent organization?

3. Is the unit satisfactorily able to perform all functions required by its missions? Are there functions in which the unit is deficient?

4. Are the functions of each branch within the psy ops unit clearly defined and understood?

5. Is there adequate coordination of functions within the unit?

6. Where all functions have not been covered, what arrangements are made to levy tasks and requirements on other organizations that possess the requisit capabilities?

7. What channels are available for psy ops units to coordinate operations with parallel agencies? To what extent are these channels used?

Personnel Capability. The following charts serve as models to evaluate the qualifications of personnel both U.S. and GVN.

Personnel Complement by Section (US personnel)	Education Level	Amt. Training in Psy Ops School	OJT	Amt. Training in Social Sciences by Science	Training Experience in Area	Special Training Skills, Statistical, Operation of Media, etc.	Language Training Competence
Section A. (functions)							
Section B.							

1. What requirements are levied for the filling of major personnel positions? Are personnel recruited or assigned to these positions?

2. Do existing personnel have adequate training and competence to perform their delegated functions? What are their qualifications?

3. Are functions of each individual clearly stated? Does doctrinal guidance exist on personnel functions?

4. Are the personnel sufficiently aware of the meaning and scope of the function to be performed by them?

Personnel Complement Vietnamese Personnel by function	Educational Level	English Language Level	Training in Psy Ops

5. Are guides available for the selection of Vietnamese personnel?

6. Are these guides adequate? Are there adequate and up-to-date biographical files on likely candidates?

7. To what extent do Vietnamese personnel now in the unit satisfy requirements?

8. Are the number of Vietnamese personnel available adequate to satisfy requirements?

9. Psy Ops Guidance for U.S. and ARVN Military Elements

By definition, psychological operations are deliberate actions conducted according to a preconceived plan. Since changing attitudes and behavior is properly considered a specialized function, it is sometimes forgotten that the engendering of psychological impressions in not the exclusive domain of experts. Indeed, the Vietnamese citizenry will probably reveive a more lasting impression of U.S. and GVN troops from personal encounters during their military operations or leave periods than from the digest of propaganda, no matter how skillfully conceibed. If U.S. or GVN military are inconsiderate of the people, if they violate the cultural standards of the host population, then the psy ops effort which attempts to build mutual trust and respect between American and Vietnamese and between the Vietnamese citizenry and solidiery is greatly attenuated. Accordingly, it is--or should be--the responsibility of civil affairs and psychological operations personnel, along with the military commander of the unit, to ensure that the soldiers adhere to an honorable code of conduct.

Often military commanders face the "double mission" problem. Often the mission against the enemy will occur in a populated area. Although the primary mission is destructive, a secondary--but nevertheless consequential--mission is to achieve rapport with the civilian inhabitants. Other missions are basically civil in orientation. For example, in operations such as Country Fair the civil mission is primary, force being required only to protect the operation. More generally, the probable psychological impact of all military operations, conventional or civil should be considered in development of mission concept and plans. Psychological operations, responsible for knowing the audience, should have a voice in assisting command in the employment of military forces.

All of these missions require the integration of psy ops into the planning and conduct of the operation. The exact nature of the plan and the extent of psy ops assistance required will, of course, depend on the mission.

Psy Ops in Conjunction with Military/Civil Relationships.

1. Is there a manual or other instructional material providing guidance for the conduct of U.S. and ARVN troops toward the civilian population? Is it adequate? Is it kept up-to-date? Is the material required reading?

2. Are means other than printed material utilized to instruct military personnel in the requisites of a proper code of behavior? What is the frequency with which troops are exposed to the media?

3. Are steps taken to apprise the U.S. soldier of the critical

psychological importance of personal encounters with the GVN military?

4. Are provisions made for the monitoring troop behavior toward the civilian population?

Psy Ops in Conjunction with the Conduct of Military Operations.

1. Are probable psycholgical impacts of military actions considered in mission plans?

2. Is advice from psy ops/civil affairs personnel requested when the mission so requires?

3. Are psy ops/civil affairs annexes to military orders prepared when needed?

a. statement of psy ops objectives and responsibilities?

b. psy ops appeals to the enemy as appropriate?

c. plans for care of civilians?

d. communications to encourage civilians to provide intelligence concerning the activities and whereabouts of VC/NVA forces, etc.?

e. instructions for coordination and control between psy ops personnel and unit commanders?

f. specific duties for psy ops personnel?

g. instructions for psy ops logistics?

h. clear command and signal instructions?

4. Are instructions in the annex implemented in the conduct of operations?

5. Is psy ops planning coordinated between allied military forces when a joint operation occurs?

SESSION 5
TRAINING INNOVATIONS AT USASCS

Chairman: Thomas Matthew Rienzi, Brigadier General, USA
Commanding General
U.S. Army Signal Center and School
Fort Monmouth, New Jersey 07703

A. INNOVATIONS WITHIN A SYSTEMS APPROACH TO TRAINING AT THE U.S. ARMY SIGNAL CENTER AND SCHOOL: Thomas Matthew Rienzi

B. COMMON BASIC ELECTRONICS TRAINING (PROJECT COBET): Charles J. Anderson, U.S. Army Signal Center and School, Fort Monmouth, New Jersey 07703

C. COMPUTER-ASSISTED INSTRUCTION: Vincent P. Cieri, USASCS, Fort Monmouth, New Jersey 07703

D. NEW HORIZONS IN TEACHER TRAINING: Joseph Frank, USASCS, Fort Monmouth, New Jersey 07703

E. SESSION SUMMARY: Thomas Matthew Rienzi

5A. INNOVATIONS WITHIN A SYSTEM APPROACH TO TRAINING AT THE U.S. ARMY SIGNAL CENTER AND SCHOOL

Thomas Matthew Rienzi, Brigadier General, USA
Commanding General
U.S. Army Signal Center and School
Fort Monmouth, New Jersey 07703

As Commandant of this School - the greatest School in the US Army - I welcome all of you.

You know, I can't help feeling that with all your great minds pulsating and cogitating in our midst, you are setting up vibrations that will linger after you, and do us all a lot of good -- just from having had you around. We'd like also to rub off a little on you.

I'm happy to have this chance to put on a little program for you today, because I want you to know why we're the greatest School. Most of you have heard about us, but you may not have neard of some of the fine exciting things we've been doing in the education field.

So I will devote some minutes to how we at the US Army Signal Center and School are dealing with that highly intriguing field of instructional systems and training objectives. As part of the packet you have received, you will find a procedures manual which describes in full detail our systems approach to training. In the next few minutes I'd like to tell you briefly how seriously and how thoroughly we are pursuing that area -- because we have believed for a long time that everything you do in a school: curriculum, media, methods, evaluation, all presuppose good objectives.

Then I'd like to show how, starting with the training objective, we will weld everything into a coherent system.

Then, how we are using our know-how in designing for USCONARC a brand-new, up-to-date basic electronics course.

Next, you'll hear about our project for incorporating the computer into our training system. We'll tell you also about our use of TV in instruction and about some of our most dynamic training aids.

During what I know have been fruitful and satisfying careers, you great folks have heard of the Little Red Schoolhouse. Quite apart from the possible political overtone of such a phrase, it dosen't apply to us. What we are

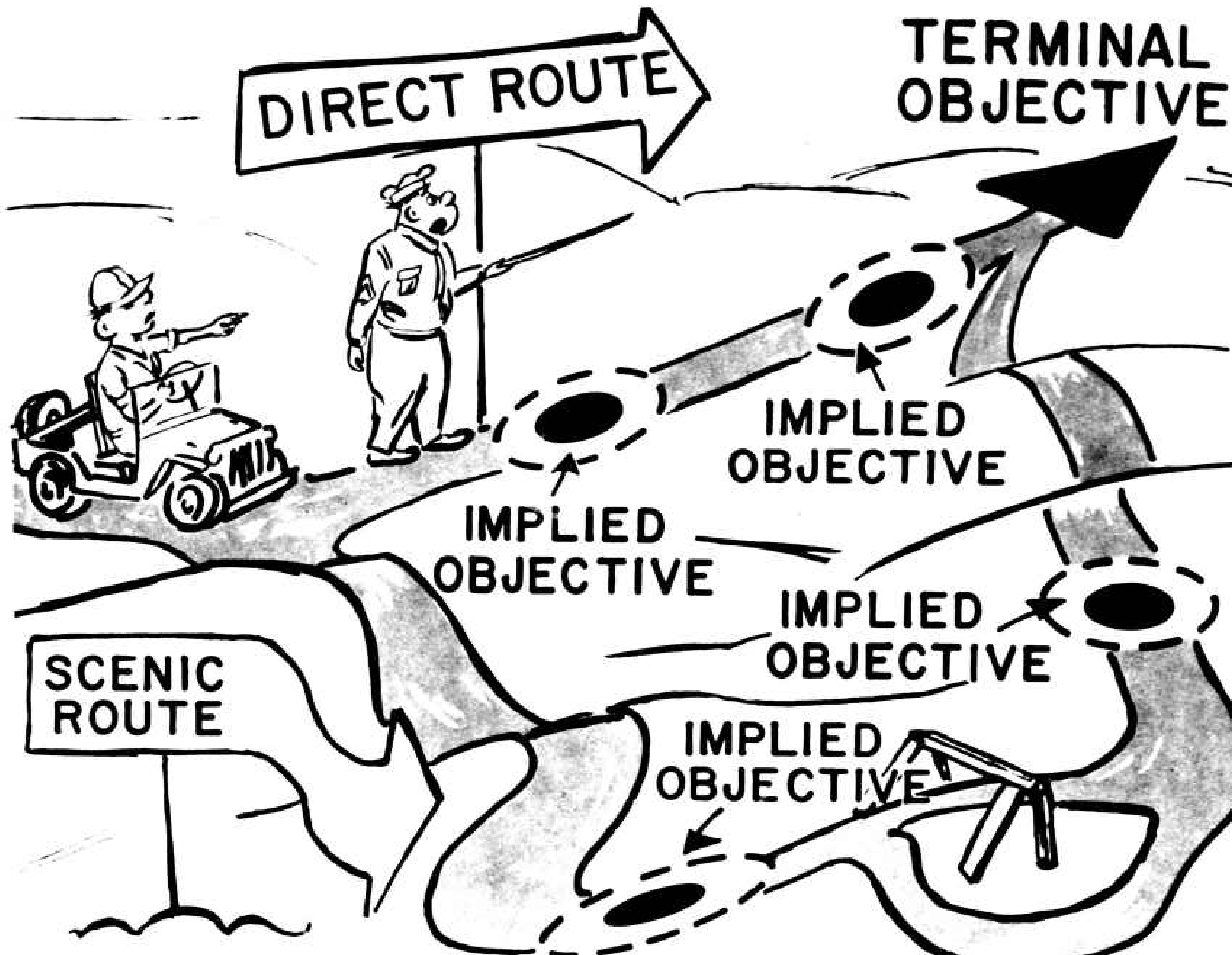

DIRECT ROUTE
TERMINAL OBJECTIVE
IMPLIED OBJECTIVE
IMPLIED OBJECTIVE
IMPLIED OBJECTIVE
IMPLIED OBJECTIVE
SCENIC ROUTE

Figure 1

detailed objectives than were originally thought necessary. For electronics tasks, these amount to a large number. Some are skill objectives, some are knowledge objectives. We want only the essential ones, of course.

We are convinced that you need a special type of analysis, starting with required skills like measuring voltage, and deriving from that the knowledges required, what we want the man to be thinking. The sum of these specific and narrow knowledges, we expect, will constitute theory, concepts, knowledge without which the man can't do the job, and only those, because we want the shortest, easiest path to the objective.

Example: If we accept the fact that, to measure a plate voltage a man must know that plate voltage is a DC, not an AC voltage, we have one step on the short path. We're confident that this is a correct step because it can be proved that if you do not have this piece of knowledge, you can't set the voltmeter right. In this instance we know we've identified one knowledge objective; and can prove and justify it.

By continuing this kind of inspired drudgery to the end, we get the raw material for our courses -- the skill and knowledge objectives. We are bright enough to see that we also have the material on which we can base our evaluation process: Our criterion measures. We can work the same material and decide intelligently -- which medium is best for each skill or knowledge objective (see Figure 2).

We can do it well because the objectives are really specific. And we can use the data to decide on approach, sequence, instructional strategy that best embodies the great human factors we are all concerned with.

You will find, in the presentations which follow, that we are totally dedicated to analyzing the objective, not just stating it.

All this stems from our work, in the late fifties and early sixties, with programed instruction.

In training our programers, we used the sample task you see here. The old Prof is teaching a class to find the unknown side of a right triangle, and his path is by way of Pythagoras. To him it means you have to teach square root and 90 degrees in a right angle, and how to recognize a right triangle.

But we found that you don't. We found you can even dispense with old Pythy and teach a man how to use a ruler. That would save having to teach square root.

Now in electronics we have the same problem: How to identify the skills and the knowledges needed to accomplish the task. We have to start with a task like troubleshooting, go to a skill like measuring plate voltage and arrive at narrow knowledge-facts like "grid voltage controls plate voltage". This is quite different from broad knowledge domains like "theory of amplification."

For Officer training, the job is

running here is a Big Green School house. Just as we have a different color, we have a different view of the job we have to do. The old view of a school where the instructor was king and beat unpleasant and unpalatable truths into unknowing and unwilling heads -- we've rejected that. Here we adopt the more humble approach of questioning everything! What we teach, how we should teach it, and why we're not getting it all across. That's our approach and while we're humble, we're not necessarily modest. We think we have something to show you today: Our own system.

Perhaps I've already slipped into an easy error in saying things like "what we teach" and "how we teach". I should have said we question what our soldier student should learn, how he best learns it, and why he doesn't learn as much as he should. This is a much better way to say it, because it stresses real problems of the student, The Human Factor -- not our view of what problems he should have. In this sense, the student is king. We don't actually coddle him -- let's just say we cultivate him.

In a minute or two, I'm going to make clear some of the specific approaches or tactics we are using as part of a multi-facet system. But give me a few moments to set the stage, and give our rationale. I don't want you to think we're shooting buckshot in the general direction of a shifting target.

Suppose this were an Army school for KP's, and suppose we had a course for potatoe peelers. We're convinced, and I know you agree, that you have to analyze the high art of potato peeling before you decide on having a two-hour block in skins, and 3 hours on eyes, and 4 hours on how to hold a spud. I can express it differently if I say that your job would be not to analyze potatoes, but potato peeling. In this connection, we have to remind ourselves that this is not a school where we study communications. No, we study (and teach) the planning, operating, supervising and maintaining of communications equipment and systems, we exist to teach folks how to do a job.

We feel that when you have the job, the objective, well defined - when you know what kind of potatoes, what size, how deep to peel -- you're off to a good start. Like a Division Commander, you have the objective -- not only in mind, but drawn right smack on the map of the terrain.

But -- and there's a big but -- you've got to consider the path to the goal (see Figure 1). What is the most efficient route to take our student to the terminal objective? A tactician would call this setting down intermediate objectives and choosing a course of action. In training we call this developing -- systematically - implied or deduced objectives and choosing the right series of learning experiences. You have to produce, by more analysis, more

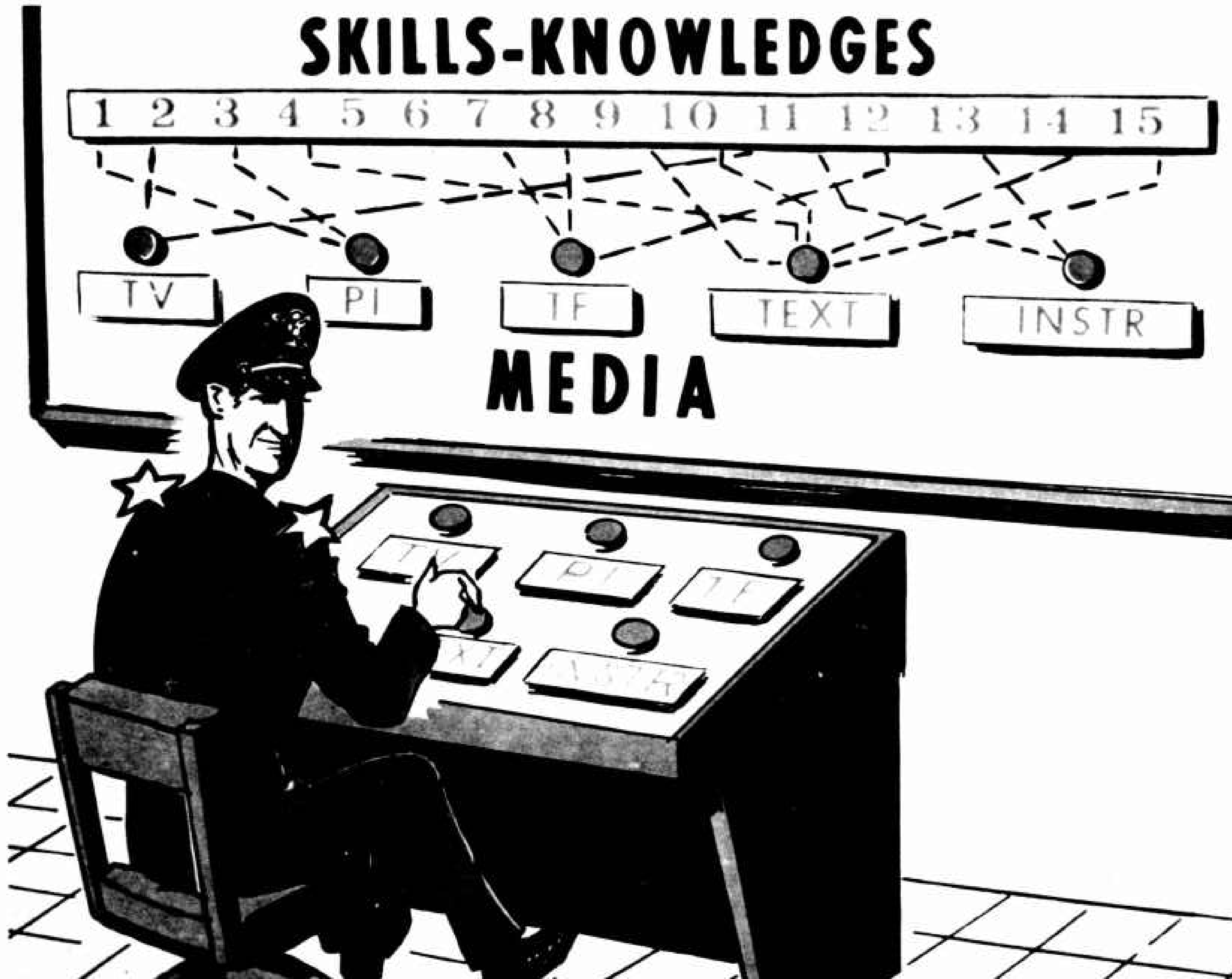

SKILLS-KNOWLEDGES
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
TV
PI
TF
TEXT
INSTR
MEDIA

Figure 2

USASCS SYSTEMS APPROACH TO CURRICULUM IMPROVEMENT

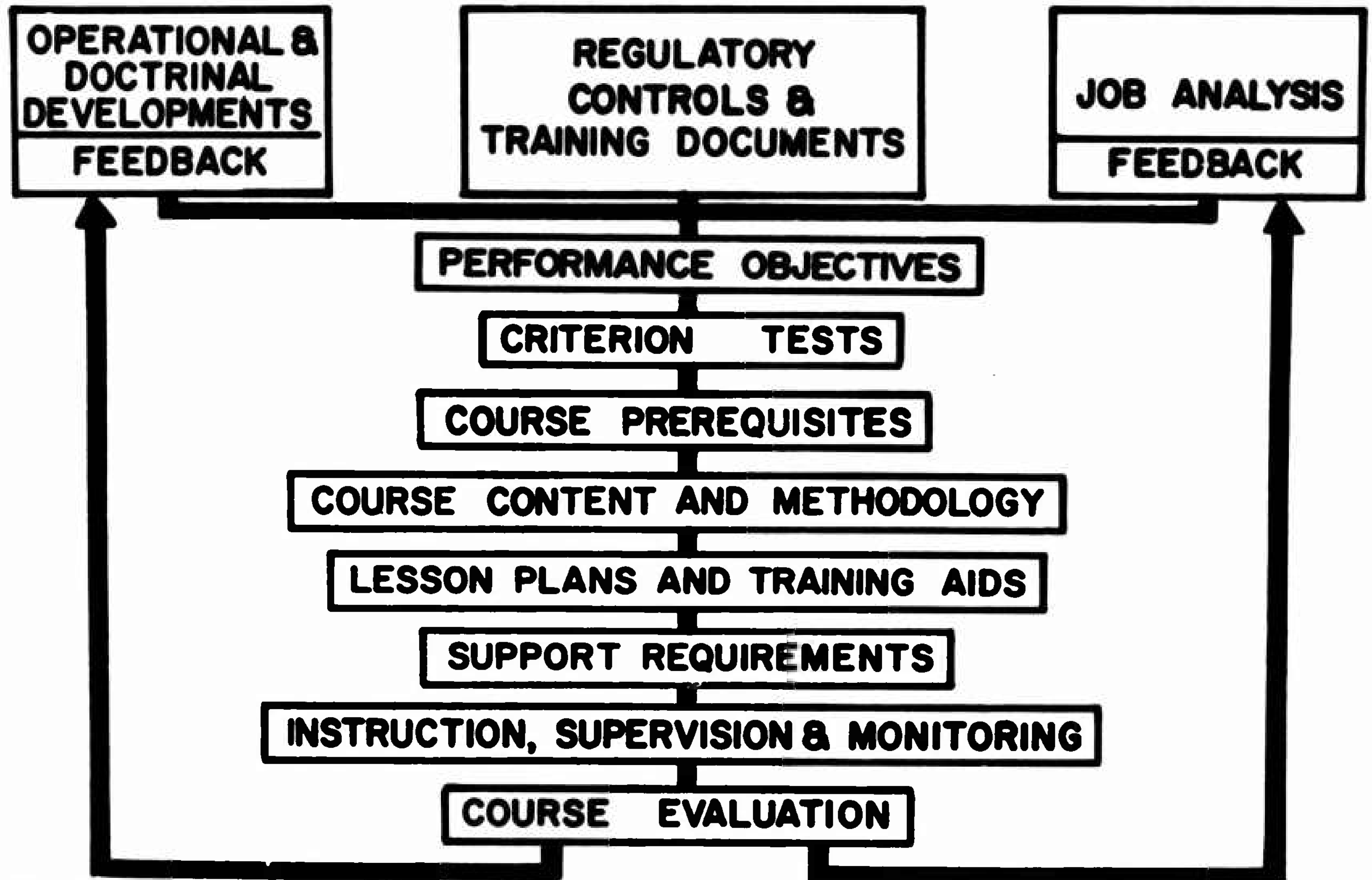


Figure 3

even more demanding. Command - plan - supervise. These are intricate tasks but we still have to define skills and knowledges and be able to justify them. An instructional system that doesn't do this, may be instructional, but it's no system. These are the main features of the system as we see it:

1. Reject broad objectives like vacuum tube theory and build content on skill and functional knowledge objectives.

2. Select training media according to the objective to be met. Here I'm talking about an objective that covers 15 minutes, not 2 hours.

3. Design an evaluation program based on that kind of objective.

Content, media, evaluation -- all come from objectives. To go from Pythagoras to Archimedes, we're after a long lever with which we can move the student from where we find him to where we want him to be.

Regardless of the kind of training -- Officer, Enlisted Technician - whether electronics or photography -- we are after a total system, not one for PI, and one for TV and one for computers. And we want that system to rest on a solid analytical framework.

Now, let me put together for you all the parts of our system for curriculum improvement (see Figure 3).

Notice that the course performance objectives are derived from a number of important inputs, including job analysis which tells us what the graduate must be able to do on the job; operational and doctrinal developments which alert us to any changes in job requirements, and feedback information from course graduates and from test data which indicates where modifications of course objectives may be desirable.

From the performance objectives we derive the detailed skills and knowledges of which I spoke a moment ago.

As we go on you will see how the remaining parts of the system contribute to the logic of the design.

Criterion measures, or tests, are based directly upon performance objectives. Course prerequisites are set with a knowledge of the kinds of skills and knowledges which the repairman must acquire and the time available for accomplishing this.

Now that we know the starting point and the proposed end point, we are ready to develop the detailed skill and knowledge objectives, the course content. Then we want to consider what methods and techniques we're going to use to bring the selected subject matter and the student together.

When content and methodology have been decided upon, we will go ahead and prepare the detailed lesson plans, information sheets, programed instruction texts, special

texts, TV lessons, graphics and special training aids required for the best learning. Of course, support requirements like facilities, supplies and equipment, as well as instructors will be needed; and these requirements that support the course must be carefully considered after the content methodology, and instructional materials have been firmed up.

Instruction, supervision and monitoring come next in the process. This is the implementation phase where we put into practice in the classrooms, laboratories, and field training sites all of the planning and coordination that has gone on up to this point.

Finally, course evaluation gives us an idea of how well we have done and indicates specific areas for improvement. In evaluating the effectiveness of each course conducted at the Signal School we use feedback in the form of close observation, questionnaires returned from course graduates and their supervisors, interviews and statistical studies. Now, into that briefly described format fits everything that this School does.

Now I would like you to hear about some of our hottest projects. You'll see that although there is considerable variety among these projects at the same time there is good integration within the overall "systems approach" I have been talking about.

First: We have something called COBET: Common Basic Electronics Training. In one area, COBET is going to tell us what must an electronics technician learn that will be common to all equipment he will have to work with. This is a project that really starts from scratch, and I'm going to ask Mr. Anderson, who's running this project, to start scratching.

Andy---

5B. COMMON BASIC ELECTRONICS TRAINING (PROJECT COBET)

Charles J. Anderson
U.S. Army Signal Center and School
Fort Monmouth, New Jersey 07703

First, what does COBET mean? Well, COBET is an acronym that stands for Common Basic Electronics Training, a course that will be used throughout the USCONARC (United States Continental Army Command) school system, and we at the Signal School have been assigned the mission of preparing the COBET course.

To make what I am going to say about COBET more meaningful I must first tell you a little about the background of the project.

Project COBET is USCONARC's response to instructions that were sent by DOD (Department of Defense) to all the services last year. Now, if you will permit me, I have extracted a small part of these instructions and I want to emphasize a few of the key phrases.

Notice that the courses shall be organized on a functional and equipment-oriented basis, and the objectives shall be to achieve competence in the troubleshooting and repair of electronic equipment. And how should this be done? Through the teaching of troubleshooting procedures, identification of trouble symptoms, and use of test equipment.

Note these important words -- Principles of Electronics, Electronic Fundamentals, Basic Physics and Mathematics shall be introduced only as necessary for the identification and repair of equipment troubles.

Guided by these instructions, we the Signal School are developing a COBET entry level electronics training course based upon the human factors involved in the maintenance, troubleshooting and repair of electronic equipment, not upon a subjective, classical approach that presents the student with a multitude of theoretical concepts that he never will use in the field performance of his job.

By direction from USCONARC the COBET must have the following characteristics:

First, and of highest order is

practical training (see Figure 1). The COBET courses must be designed to provide at least 75% practical, hands-on-equipment work to no more than 25% conceptual-type training.

The second characteristic is that the COBET course will be individually paced (see Figure 2) which means, of course, that the student will move as fast as he can according to his own ability. No student will be held back because other students are slower than he is -- no student will feel pushed because other students are faster than he is. Each student will move ahead at his own rate.

The next characteristic is that the course must also provide for total efficiency, including built-in transfer training, but not for enrichment (see Figure 3). In other words, the student must spend the major part of his time learning the essential skills and knowledges that he needs to be able to troubleshoot and repair many kinds of electronic equipment. We must recognize that we are not starting out to produce full career training in great depth. We are concerned with training repairmen--not research and development engineers!

The fourth characteristic, as directed by USCONARC is that we must use to fullest advantage audio visual instructional systems and devices (see Figure 4). By research and experience we know that students entering military electronics training respond more readily to audio-visual presentations than to just verbal stimuli.

So we will take full advantage of the instructional systems concepts that are now available.

Finally, the fifth characteristic is performance oriented testing methods (see Figure 5). We will not be satisfied with giving the students written tests in which they tell us how they would use test equipment in a certain situation. Instead, we will give the student the equipment and have him show us that he knows how to use it -- not just tell us about it.

Now, given these clear directions from DOD and USCONARC, what are we at the Signal School doing to ensure that the proper training results? Well-- we began by surveying the 74 electronic equipment repair MOS courses to be served by COBET. (Incidentally, these courses are conducted at 10 of the 26 USCONARC schools.)

The purpose of our survey was to find out what specific stages or circuits are most common to the equipment that the student must troubleshoot and repair in his field job. We found out that about 186 different circuits are common to the field equipment. So we compiled a list of these 186 circuits and asked the schools to give us the following information.

As you can see in Figure 6, we first wanted to find out if the students used these circuits at all.

Next, if he merely adjusted them, if he aligned them, if he had to troubleshoot them, if he had to measure in these circuits, if he

PRACTICAL TRAINING

Figure 1

INDIVIDUAL PACING

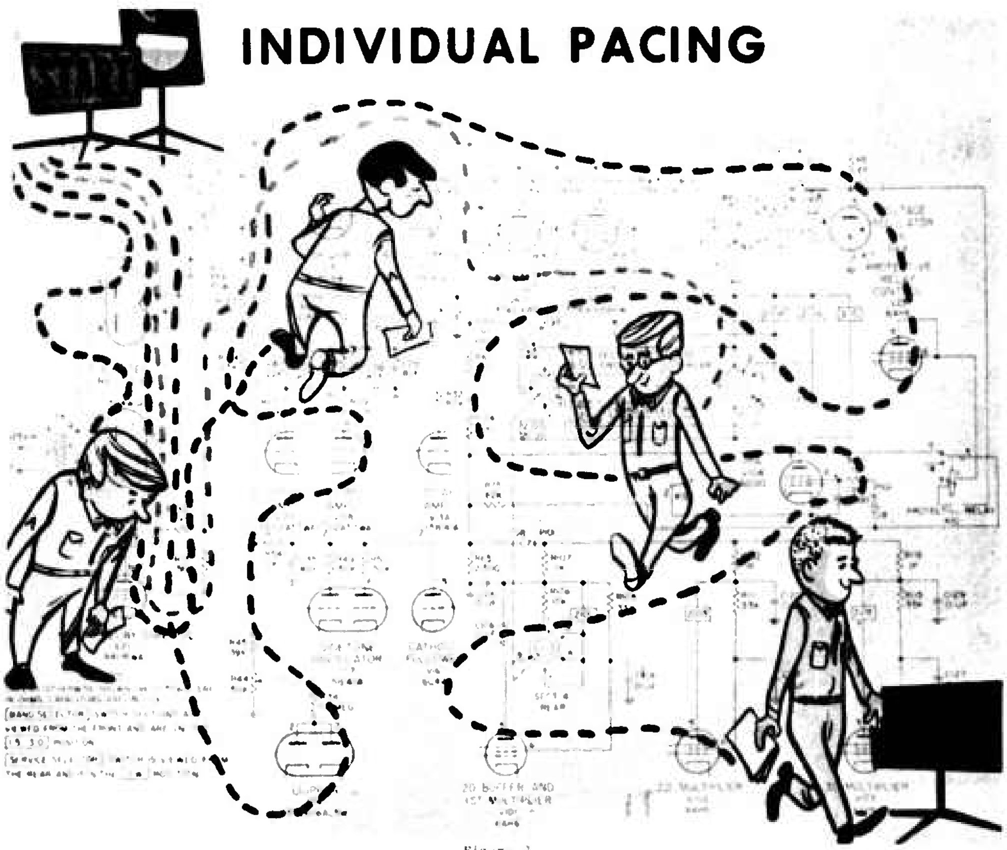
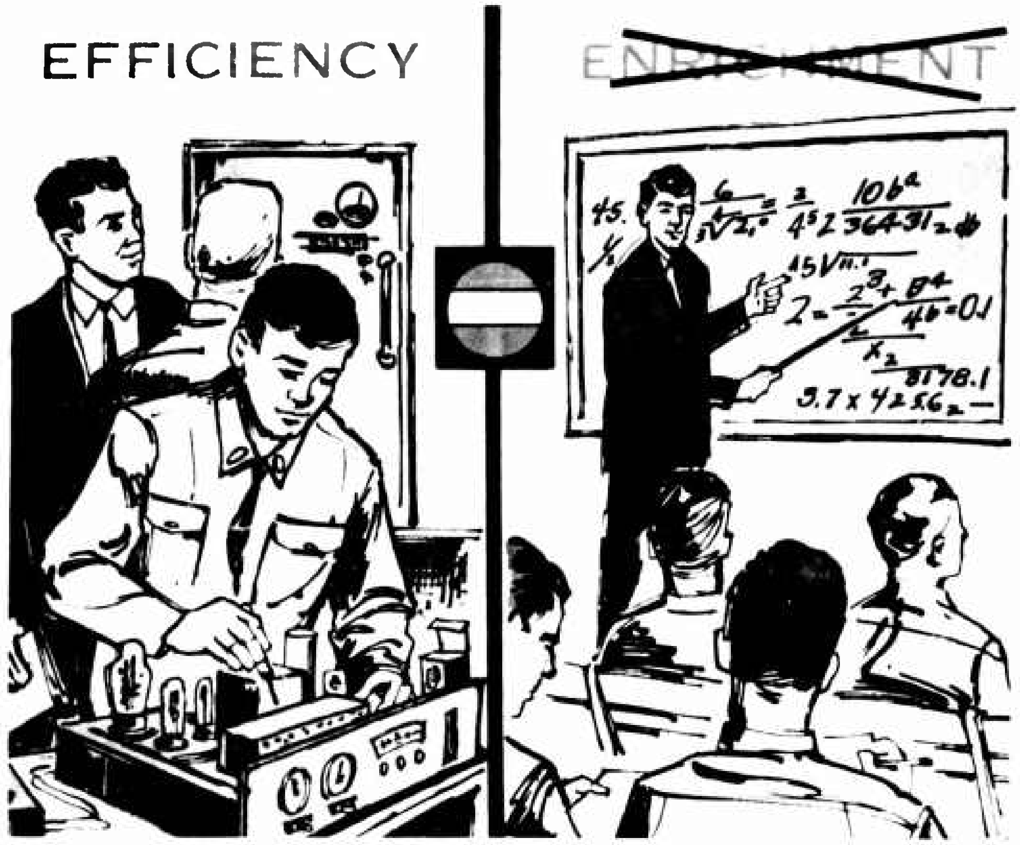
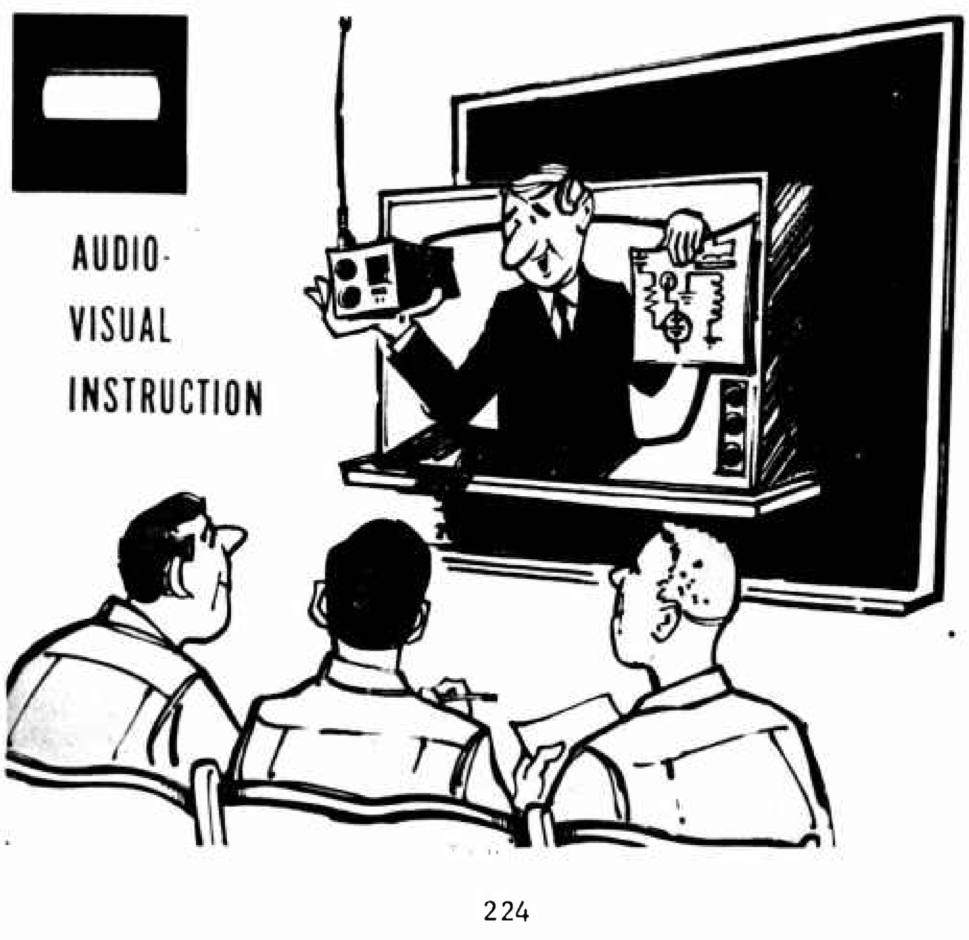


Figure 2


EFFICIENCY
~~ENRICHMENT~~


AUDIO-
VISUAL
INSTRUCTION

PERFORMANCE-ORIENTED TESTING METHODS

COMMON CIRCUIT SURVEY

CIRCUITS GROUPS	CIRCUITS	NOT USED	ADJUSTS	ALINES	TROUBLESHOOTS	MEASURES	REPAIRS	REPLACES UNIT
R-F AMPLIFIERS (35-44)	35. PENTODE, VOLTAGE							
	36. TRIODE GROUNDED-GRID							
	37. CASCADE							
	38. CASCODE							
	39. TUNED INTERSTAGE (I-F)							

had to repair them, or if he merely had to replace them.

Our main objective in this survey was to determine just how many of the 186 circuits were most common. We knew that we could not use the full 186 circuits: we had to reduce the total number to fit a course of about 8 to 10 weeks.

After analyzing the data returned by the 74 courses, it turns out that there are about 45 different circuits that are most common to the equipment tha. the student must learn to repair.

The next step then was to write out terminal per ormance objectives or TPO (as we call them) consisting of tasks, conditions, and standards using the 45 circuits as a basis. These TPO were designed to bring the student to an achievement level that would enable him to troubleshoot and repair each of the 45 circuits.

Now, it is at this point in the course building process, that is, after the TPO have been written, that we really begin to specify subject matter content. We do this by deriving from the TPO the precise skills and knowledges that a repairman must have to perform his repair job effectively.

Now, what kind of course will result from this thorough analysis process?

Let me cite briefly at least 5 elements that this course will contain that are related to the human factors involved in the troubleshooting and repair of electronic equipment.

First, our main objective is to build into the learning environment whatever elements are needed to ensure that the student will be able to make an easy transition to his field repair job environment without suffering a great loss in performance efficiency. We therefore, have been studying those physiological and psychological factors which so deeply affect the adaptation of a human operator to a new and strange environment.

A first step toward a solution of many of the inherent problems is to have the student work with equipment that is similar both physically and electronically to that which he will meet in the field.

You can see in Figure 7 what we are calling a TPO equipment unit. This one happens to be a regulated power supply. You will notice that it is not a typical breadboard type setup but rather a genuine piece of equipment. Throughout the course, the student will troubleshoot, maintain, and repair several of these TPO equipment units as he learns applied electronic fundamentals in the context of the field job to which he will later be assigned. Another important point here is that he will also use the very same test equipment that he will have to use in his field job assignment.

Continuous active involvement of the student is another human factors element that we are engineer-

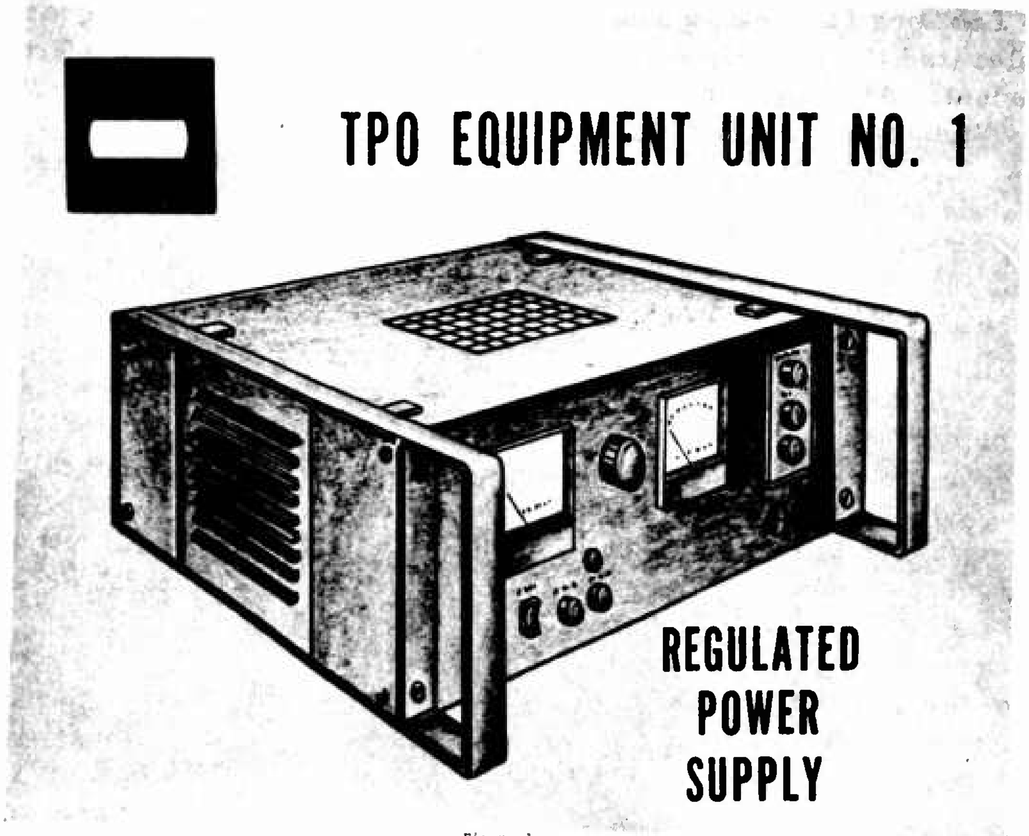


Figure 7

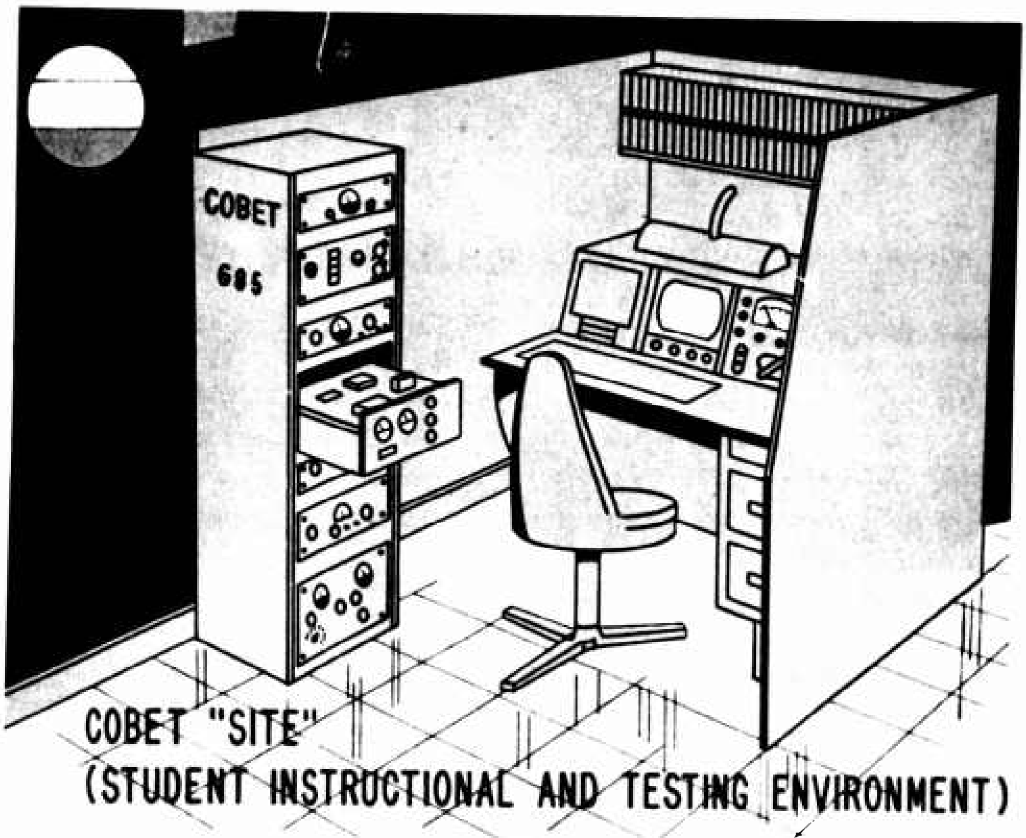


Figure 8

ing into the COBET course structure. Too long have we in education tolerated the passive role of the student. Allowing him to "tune in" and "tune out" on our instruction at will. No--in COBET we will involve the student totally and continuously, taking full advantage of his sensory and motor aptitudes, and he will provide us and himself with continuous feedback on his learning process as his learning is reinforced. Active involvement of the student is the key to learning which somehow seems to have been forgotten about since it was first introduced by Socrates many centuries ago.

A high level of motivation is another important hallmark of the COBET course. I don't know if I can guarantee the high level of motivation demonstrated by the student shown here. But, we are structuring a learning environment that will make judicious use of prevalent instructional systems media in the most appropriate mix that will accomplish the terminal performance objectives. In addition, we will also take full advantage of distributed learning concepts to defeat these three enemies of motivation: boredom, fatigue, and monotony.

To further enhance motivation and to provide continuous learning reinforcement, our students will be given immediate knowledge of results on a continuous basis. Here we will practice what we have learned from our long experience in programmed instruction. We will use whatever forms of reinforcement that best suit the learning situation, including graphic confirmation, verbal confirmation, and live confirmation. By "live" I mean having an instructor check the student's performance and say, "Yes, you have soldered that connection properly", or "Yes, you have located the faulty component."

Finally, I want to mention again the learning pace as an equally important human factors element. As I have said, the COBET course will be self-paced; and self-pacing obviously connotes training that will treat the individual differences of our soldier students.

To help accomplish these COBET goals, we are developing what we are calling a COBET site. (Site, by the way, is an acronym for student instructional and testing environment.) You can see one prototype model in Figure 8. Notice that the site provides a trouble-shooting and repair workshop environment as well as learning environment in which we will ---

a. Actively involve the student;

b. Pace his learning according to his ability;

c. Provide him with immediate knowledge of results;

d. Communicate with him by means of modern instructional media; and most important

e. Provide him with the basic electronic skills and knowledges he needs to become an electronics

equipment repairman.

That completes by brief presentation on project COBET. I hope I have been able to communicate to you some idea of how the Army is moving in the area of electronic training, especially with regard to our systems approach and our consideration of the student as the most important element in the course building process.

5C. COMPUTER-ASSISTED INSTRUCTION

Vincent P. Cieri
U.S. Army Signal Center and School
Fort Monmouth, New Jersey 07703

I am certain that all of you are aware of the growing pressures in recent years toward improving the effectiveness of education and training. Experiments in the laboratory and in the classroom with automated, learner-centered instruction have resulted in increased awareness, understanding and insights into the human factors involved in the learning process.

The technology which is emerging from these investigations has generated a number of innovations in education and training methodology. Among these innovations computer-assisted instruction appears to be one of the most promising.

I would like, therefore, to speak to you briefly about our effort here at the Signal School to improve our training effectiveness through the development and implementation of computer-assisted instruction (or CAI) in electronics training. The symbol, incidentally, which appears on the screen, represents the hallmark of our CAI effort.

The computer-assisted instruction project was assigned to the Signal School by the US Continental Army Command in response to direction from the Department of Defense and the Department of the Army. These instructions urge the exploitation of innovations in education and training with the view of obtaining significant improvements in the effectiveness and efficiency of military training.

The preceding presentation of project COBET gave you a picture of one of the significant and important studies aimed at the improvement of CAI as a medium of instruction in COBET. This was intentional. Before we can incorporate the computer in project COBET, or for that matter, in any electronics training, we have much to learn. We need to know how and where it can be used to the greatest advantage and we need to know how best to combine it with other instructional methods. These are some of the reasons why our CAI project is being

undertaken as a separate entity. Once we gain the necessary know-how we will then be in a reasonable position to apply this method of training with reasonable confidence.

There are a number of aspects of CAI that, in our opinion, offer great potential for improving training not only in electronics, but in other subject matter areas as well. We will consider three of these areas - the ones that we feel are most significant.

The first and most important aspect concerns itself with the well know fact of individual differences. No two of us look alike, think exactly alike or learn alike. CAI being a highly adaptive method of instruction automatically seeks out the best learning path suited to the individual learner's needs and aptitudes. Thus, a slow student is not pushed by students who are much better equipped to move along at a rapid rate, and, the fast student is not impeded by those students who cannot move along at this rapid rate. In essence, CAI accommodates individual differences by providing a unique learning path for each student. This is the ultimate in the individualization of instruction - a goal which up to this time has been impractical in the training of large numbers of students such as we are faced with in military training.

The second aspect that is of great interest to us is the capability of CAI to gather, with relative ease, data in sufficient quantities and under uniform conditions about the progress that students make. For the first time we will have at our disposal detailed evidence of how well our lessons perform. Revisions then can be based on objective data in contract to personal and often opinionated documentation. In addition, the data we collect on student performance will enable us to do a better job in preparing new lesson materials. This type of feedback, which serves to close the instructional loop, will add a new dimension to course preparation and management.

The third interesting aspect of CAI is its multi-media capability. You and I, in our own education, received much of our knowledge from and with words in books. However, we must face the fact that many of our military trainees are not academically oriented. They learn most efficiently from a multi-media approach to learning in which the audio-graphic mode predominates. The computer can provide instruction in many different combinations of the verbal, graphic and audio forms. It can be used to turn on any kind of instruction. It can control TV receivers, audio-visual devices or guide students through some piece of equipment. In fact the variety of media that can be used and controlled in a CAI program is limited only by the imagination and skill fed into the preparation of the lesson material.

Thus far I've told you what we think of CAI, now, I would like to cover briefly what we here at the Signal Sch ol are doing with this

innovation in training technology.

At the present time we are conducting a study of the feasibility of using the computer in electronics training. This feasibility study is more than an arm-chair routine. As a matter of fact, a major part of the study is geared toward practical application. To this end, 12 hours of conventional instruction have been converted to a CAI format. At the present time this instruction have been converted to a CAI format. At the present time this instruction is being given to Signal School students via the IBM 1500 Instructional System utilizing the facilities located at the US Naval Academy. To the greatest extent possible we have incorporated the "hands-on" concept of training in the converted CAI lessons. An application of this principal in the feasibility study is evident in the CAI course segment on the care and use of the multimeter. For example, in this instance the student is instructed by the computer to measure the voltage between two points on a circuit board. The student responds by taking the measurement and then typing his answer on the keyboard. The computer then presents the next frame if the student's response is correct, or, if the response is incorrect it guides him to the correct measurement step-by-step. This practical application of CAI is relatively new since up to this time most of the developmental work in CAI has dealt primarily with verbal subject matter. However, our application of CAI for "hands-on" training stems from our conviction that virtually no limit exists in the type of training that can be provided by the computer.

Another benefit we hope to derive from the feasibility study is to determine just exactly what role the computer can play in the total training program. We want to find out just how we can combine this instructional technique with other instructional media. This means that we are not looking to the computer as a panacea for all the training problems that we may have. Rather, we are looking to CAI as one of the teaching methods which will eventually become part of an integrated training system utilizing the media best suited to the type of subject matter being imparted.

The feasibility study also includes a comparison of the significant performance factors to determine the relative academic and cost effectiveness of CAI compared to our on-going training program. In other words, we are going to match up this new method of instruction with conventional instruction and see just how it measures up.

Finally, this study will provide information on the state of the art of CAI as it stands today to determine the configurations of CAI systems which will be best suited for military training.

Although the feasibility study is being performed by a contractor we at the Signal School have no intention of losing the important

experiences to be derived from the process of adapting basic electronics subject matter for CAI presentation. We have a CAI project group formed at the School working side-by-side with the contractor personnel. The know-how obtained by this group through the feasibility study, is the initial step in the acquisition of an in-house capability in this field.

If the feasibility study gives CAI the green light and we hypothesize that it will, we stand ready to immediately exploit the full potential of this promising instructional technique. The large scale plan which we have already prepared calls for the application of this technique for teaching 204 hours of basic electronics as well as a 40-hour block of instruction in new equipment maintenance training.

Up to this point, I have not made mention of the instructor's role in CAI. I have deliberately left this point for the last part of my presentation for very good reasons. We feel that the instructor is the key element in the man-machine interface of CAI systems. To say that the computer will replace the instructor is equivalent to stating, if you will excuse the analogy, that the bulldozer can replace the muscle. Without the man in the driver's seat, the bulldozer is useless. By the same token, CAI can be as good as or as bad as the people who generate the lesson material or software for it. In this respect, we feel that CAI will call for a new breed of instructor in military training. We see this instructor as the subject matter specialist who is critically involved in the preparation of lesson material or software. We also see him highly skilled in handling unique student problems unanticipated in the software or beyond the capability of the computer. In short, the role of the instructor as the imparter of rote subject matter will be diminished. His role as a tutor will be vastly increased. The computer, then, will free the instructor to give personal attention to the students who need it the most. These students generally are in the lower aptitude levels and make up most of the attrition in the enlisted courses here at the Signal School.

I have in a few minutes sketched out our CAI effort. We feel that, although it is only a beginning good progress is being made. However, we have much to learn. As we learn we would like to share this knowledge with anyone interested in computer-assisted instruction. We invite all with an interest in this field to a free exchange of information, for it is in this spirit of mutual cooperation that this innovation in training technology will develop with the greatest efficiency.

5D. NEW HORIZONS IN TEACHER TRAINING

Joseph Frank
U.S. Army Signal Center and School
Fort Monmouth, New Jersey 07703

The advances in training technology which you have seen and heard about in the Common Basic Electronics and Computer-Assisted Instruction presentations meet a very great need in our civilian and military educational programs.

As you know, today's training technology will relieve the instructor of much of his instructional load, but he will play a greater role in the individual training of the student. As the key person in the educational process, his role will be of a Socratic nature and curriculum specialist, always keeping in mind, however, the importance of the human factor in training - the student-teacher relationship.

In a systems approach, training and content are slanted toward achieving terminal objectives through the use of multi-media, such as closed-circuit television and the techniques pointed out in COBET and CAI. These media present subject matter geared to the student's individual capabilities. But when we are confronted with students' personalities and interests, the instructor remains the keystone in the training arch. For optimum communication the instructor, therefore, must receive the type of training best adapted to the newer techniques and to the needs of the military educational system.

In this presentation, we are going to be concerned with how the Signal School trains the instructor to teach that which should be taught - as explained in your copy of the "Curriculum Development and Improvement at the US Army Signal School." Specifically this relates to the inter-relationships between the skills, attitudes, and behavior patterns of the Signal School instructor.

Just as a matter of background, 90% of those who are assigned to teach in the Signal School have no instructional experience. They consist of officers and enlisted men who have just returned from overseas assignments or who are recent graduates of a Signal School course - or civilians who are

technically qualified in communications-electronics equipment. In order to teach effectively and efficiently. These people must be trained to meet the criteria established by the Department of the Army and the needs of the Signal School. As in all areas of military training, teacher education is limited by the time factor. Within a period of six to ten weeks, our Instructional Methods Division qualifies instructors to teach effectively because its program has been streamlined to a point of minimum theory and maximum practice. Based on years of experience, we know that training neophytes to become more effective instructors means getting down to the raw elements of teacher training. Despite this, we still have some time for the niceties of teacher education, such as the psychology and philosophy of education, professional growth and development, and the like.

Teaching is specialized behavior. The neophyte trainee asks, "How can I do the job better?" He wants to know how to improve - what he did well - what he did poorly. He must have appropriate comments on how to better his teaching. In the words of the professional educator, he must be reinforced. To meet this need, the desired behavior patterns and the purposes of instruction are clearly defined in the subject matter presentations during the instructor training course.

The Signal School is the pioneer in utilizing closed-circuit television to train its instructors. The Instructional Methods Division since 1961 has successfully used the television camera in teacher training. We have now reached a point where closed-circuit television provides maximum return in terms of instructor-trainee behavior. We are very proud of the fact that other service schools have patterned their television instructor training programs after ours. In collegiate circles the micro-teaching television techniques used at Stanford University since 1965 are very similar to those of the Signal School. Our technique is unique in that the television camera is out of sight. The classroom situation is realistic, and there is provision for immediate playback. The video-tape which you are about to see describes the program and one of the most successful uses of closed-circuit television. As experienced professionals, I am sure that you will observe some of the trainees' teaching errors. These are the behavior patterns which we help the trainee to overcome. (Two and one-half minute video tape was shown.)

In the 5-minute exercise before the TV camera, we are primarily concerned with the behavior patterns of the instructor-trainee's personal qualities - his appearance and bearing, his speech, and teaching personality. This is a follow-up of the subject matter which had been previously presented in class. Reinforcement takes place as a result of his fellow students' comments, and the guidance of the Instructional Methods Division instructor. What has taken place may shock the trainee. At least,

he is able to see for himself those areas which need improvement, and how he can use his strengths to correct or eliminate his weaknesses.

His second exposure to the television camera in the 20-minute lesson achieves still more in the trainees development. Here we are looking for instructional behavior qualities in addition to the personal qualities observed heretofore. These include the effects of his preparation and planning, his knowledge of the subject, lesson presentation, student participation, questioning techniques and encouraging student participation. Presentation skills and reinforcement of correct behavior patterns are the objectives of this phase of closed-circuit television for training instructors.

Improvements in using television tapings continue in the Signal School. For example, we know that one very important element in our present approach is the inability to observe student reaction. This is as important to the trainee as his own behavior patterns. From student feedback he knows whether he is communicating. This is the basis for the teleidoscopic approach in human behavior. The teleidoscope gets its patterns not only from what is within a structure, but also the raw materials from the outside or the changing environment upon which it focuses. Thus with the individual there are elements in his structure which are constantly played upon by the external input through his senses. Applying this to instructor training, we now have plans to observe student reaction by taping the class at the time the trainee presents his lesson. The playback will be on a split-image screen or a separate playback to be viewed by the trainee and his instructor. Experimentation will determine the best way to employ it. For a look into the future let us take a brief look at this technique (three-minute video tape was shown).

In summary, we know that our present method of using closed-circuit television as a medium for training instructors has been successful. It has changed their behavior patterns for the better by helping the instructors adapt their personalities to recommended teaching techniques as reflected by the comment in the first tape - "Now I really see." We hope that the teleidoscopic approach will go even further.

5E. SESSION SUMMARY

Thomas Matthew Rienzi, Brigadier General, USA
Commanding General
U.S. Army Signal Center and School
Fort Monmouth, New Jersey 07703

In my introduction, a little while ago, I outlined our system for curriculum development and improvement in order to provide you with a frame of reference for the subsequent presentations. Then in the short time we had available, we have taken a quick look at a number of projects, or innovations, which have been applied to selected areas within the system. I think you can see how our COBET project is directly related to performance objectives, both CAI and the new instructor training techniques are concerned with methodology and instructor support requirements, while Mr. Abatiello's "monster" is a special innovation in the area of training aids and devices.

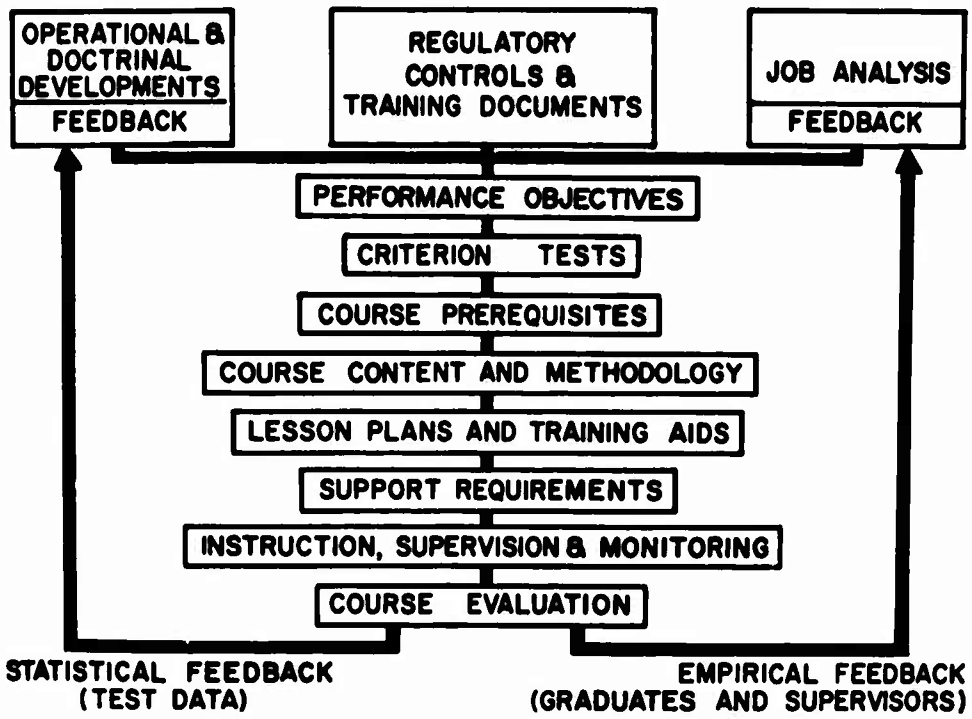
One element of the system which we have waited until now to present is course evaluation. This includes the feedback of data and information which we need to maintain and improve the effectiveness of our courses. We utilize two types of feedback; first, analysis of test results, and secondly, follow-up of graduates after they have been on the job performing the duties and tasks for which they were trained (see Figure 1).

Referring to the same chart you saw earlier, you can see that through these two types of feedback - test data and empirical feedback - we close the loop in our system and derive important new inputs for course improvement.

Because our criterion tests are based directly on detailed performance objective statements, a careful analysis of how students have performed on these tests can give a good indication of expected performance on the job. Low test scores in specific areas indicate points where we must make a reexamination of objectives, content, methodology, instructors, and other elements of our instructional system.

Another method of acquiring feedback for evaluative purposes is our Training Evaluation Questionnaire Program which provides empirical feedback from the field. This empirical feedback is what

USASCS SYSTEMS APPROACH TO CURRICULUM IMPROVEMENT



EXCERPTS FROM ENLISTED GRADUATE QUESTIONNAIRE
FIXED STATION TECHNICAL CONTROLLER (MOS 32D20)

JOB TASKS		How often have you done this task in the past 3 months? Is it now easy or difficult?					
	Never	Monthly		Weekly		Daily	
		Easy	Diff	Easy	Diff	Easy	Diff
3. SYSTEM OPERATION							
a. Operated control or testboard to perform system & circuit operational tasks	1	2	3	4	5	6	7
b. Coordinated system and circuit lineup & other operational adjustments via order wire	1	2	3	4	5	6	7
c. Coordinated establishment of system and/or circuit	1	2	3	4	5	6	7
d. Placed newly established circuit into operation	1	2	3	4	5	6	7
e. Coordinated establishment of local TP and TTY loops	1	2	3	4	5	6	7
f. Activated or deactivated circuits or channels as required by traffic load	1	2	3	4	5	6	7
. . . .							
14. WORKED ON FOLLOWING EQUIPMENT							
a. AN/FCC-3	1	2	3	4	5	6	7
b. AN/FCC-18(U)	1	2	3	4	5	6	7
c. AN/FGC-5	1	2	3	4	5	6	7

Figure 2

really tells us how successful the training has been. The data for this evaluation is gathered after graduates have been working for at least six months in the duties and tasks for which they were trained. This gives each graduate sufficient time to discover in detail how closely the instruction he received corresponds to the work he has been required to perform on the job. The discovery of significant differences between training received and duties and tasks performed, can indicate a need for new or revised course content, changes in emphasis, or even complete deletion of specific blocks of instruction.

For this program, a pair of questionnaires has been developed - one for the course graduate and one for his supervisor (see Figure 2). These questionnaires are mailed to the Commanding Officer of the unit to which the graduate is assigned, with a covering letter which I sign as Commandant of the Signal School. This letter explains the purpose of the evaluation program and solicits cooperation in the return of the completed questionnaires.

Separate self-addressed return envelopes are furnished for the graduate and for his supervisor. This facilitates the return of the questionnaires, and also provides some reasonable assurance that they will be filled out and mailed independently. Incidentally, almost 80 percent of the questionnaire which we send out are returned with useable information, and this we think is quite remarkable.

Let me give you a few examples of how feedback through the program has given us objective information to support decisions for curriculum change.

A survey of Radar Equipment Repair Course graduates revealed that few of them were working on the MPQ-10 Radar. This finding was the basis for reduction in training time on the equipment from two weeks to one week.

The need for familiarization with frequency division multiplex equipment was brought out by a survey of the Microwave Radio Repair Course graduates and as a result, the program of instruction was revised to reflect the required changes. A survey of graduates of the Fixed Station Radio Equipment Operation Course indicated the need to strengthen training of fixed plant carrier equipment. To correct this situation, the training time on this equipment was almost doubled. The same survey revealed that no graduates worked on Telegraph Terminal Set, AN/FGC-1. Therefore, this equipment was deleted the Program of Instruction, making time available for other requirements.

Surveys have also revealed new job areas. Questionnaire findings for the Photographic Laboratory Operation Course indicated that graduates were working on aerial cameras, and developing color prints. The Program of

Instruction, which at the time did not include training in these tasks, had been revised to include this training. Likewise, the prevalence of solid state TV equipment in the field, and the need for furnishing training in this area, was brought out by the analysis of information returned by graduates of the TV Equipment Repair Course.

These are only a few examples of how the findings of training evaluation questionnaires have been applied to the development or revision of courses of instruction, but they suggest the importance of the Training Evaluation Questionnaire Program in updating and improving the effectiveness of training in the Signal School.

In summary, then our little presentation here this afternoon are illustrative of specific areas within our systems approach to training. The overall curriculum system brings together a meaningful pattern, all of the most recent ideas, studies, and proposals related to military and technical training. Within this pattern a logical system of interacting purposes and relationships is evident, and available for the guidance of instructors and instructor support personnel. This system approach to curriculum development and improvement, represents one stage in an on-going search for more efficient and more effective programs of education and training at the Signal School. Within the current time period at least, it provides a framework for objective and orderly curriculum improvement.

This concludes the presentations to be made in this auditorium this afternoon, but during the remainder of the day you will be taking guided tours of various School activities.

We hope you have found the session both interesting and informative. We have certainly enjoyed having you with us.

Finally, let me take this opportunity to invite you to visit the School again, either individually or in groups, at any time. You will always be welcome.

SESSION 6
SYSTEM PERFORMANCE CRITERIA

Chairman: Robert Chaillet
U.S. Army Human Engineering Laboratories
Aberdeen Proving Ground, Maryland 21005

A. SOME CRITERION PROBLEMS IN THE DESIGN AND EVALUATION OF MAN-MACHINE SYSTEMS: Mrs. Emily J. Jones, U.S. Army Human Engineering Laboratories, Aberdeen Proving Ground, Maryland 21005

B. MISSION-RELEVANT PERFORMANCE CONSIDERATIONS IN EQUIPMENT DESIGN: Russell M. Phelps, Captain, USA, U.S. Army Human Engineering Laboratories, Aberdeen Proving Ground, Maryland 21005

C. HUMAN PERFORMANCE RELIABILITY - MEASUREMENT AND PREDICTION IN SYSTEMS OPERATION: H.L. Williams, Martin Marietta Corporation, Orlando, Florida 32805

D. INTEGRATION AND APPLICATION OF COMBAT RELEVANT TASKS, RELIABILITY AND EFFECTIVENESS CRITERIA TO SYSTEM DESIGN: John R. Erickson, U.S. Army Human Engineering Laboratories, Aberdeen Proving Ground, Maryland 21005

6A. SOME CRITERION PROBLEMS IN THE DESIGN AND EVALUATION OF MAN-MACHINE SYSTEMS

Mrs. Emily J. Jones
U.S. Army Human Engineering Laboratories
Aberdeen Proving Ground, Maryland 21005

INTRODUCTION

A comprehensive discussion of criterion problems in the development of systems is not possible in the time allotted. Logically, then, an analysis in depth of a single category of criterion problem would be the most productive alternative. Unfortunately, even such a narrowing of focus is not entirely possible, since procedures for categorizing problems of criteria have not been standardized across the many disciplines contributing to the development of systems. A corresponding lack of compatible terminology makes it difficult to relate these problems logically, as they have been conceptualized. So, this presentation will be an attempt to examine some of the problems involved in criterion establishment as they appear in selected studies. Studies were chosen on the basis of the extent to which difficulties reported by the authors appeared to be problems of criteria. Moreover, I have assumed a parallel between problems of quantification, and problems of criterion establishment as they relate to systems performance. The degree to which this assumption is tenable remains to be established.

Many authors have noted the lack of an acceptable general theory of systems which would include constructs capable of subsuming all operations in a given area, and provide an appropriate terminology. Any attempt at an overview will itself, therefore, probably exhibit weaknesses ascribable to this lack of a common frame of reference. Before discussing the implications of this lack at the level of criteria formulation, it may be of some use to consider briefly the origins of the problem.

HISTORICAL BACKGROUND

The proliferation of scientific disciplines, each with its own methods of acquiring, measuring, manipulating and rationalizing data is a reflection of the ascendency over the last 70 years of an ever-increasing commitment

to the values of operationism. In 1927 P. W. Bridgeman wrote: "Looking now to the future, our ideas of what external nature is will always be subject to change as we gain new experimental knowledge, but there is a part of our attitude to nature which should not be subject to future change, namely, that part which rests on the permanent basis of the character of our minds"... (that is, our concepts)..... "The concepts useful in Physics are and should be... nothing more than a set of operations. The concept is synonymous with the corresponding set of operations." (1) In his "look to the future", Bridgeman (1) also foresaw that, "Operational thinking will at first prove to be an unsocial virtue; one will find oneself perpetually unable to understand the simplest conversation of one's friends, and will make oneself universally unpopular by demanding the meaning of apparently the simplest terms of every argument". Had he also foreseen that his colleagues twenty years hence would be participating in Interdisciplinary Teams, for System development, against rigorous constraints of time, money and performance standards, he may have manifested a greater concern for the utility of common communications.

Despite obvious problems in communications, interdisciplinary teams did, in fact, learn to produce systems during and after the crisis occasioned by World War II.

Since this period there have been two new disciplines in the scientific world whose rise has shown a curious concomitance and whose effects have both been in the direction of pressure for synthesis. These are, Operations Research and Human Factors Engineering. The operations researcher seeks criteria with relevance for the over-all system; the human factors engineer for criteria relevant to over-all human performance. Their urgent unsolved problems have often been similar however, and in some cases identical, because the human is a part of the system at nearly every level. It has been said: "To quantify systems effectiveness, we must quantify human performance effectiveness." (2) We will now consider some of the problems that have been encountered in the attempt to implement this philosophy.

THE NATURE OF THE SYSTEMS CONTEXT

Almost from the beginning, the initial, if not the principal difficulty confronting the systems oriented researcher has been the enormous quantity of detailed information required to describe a single system. (3) (4) (5) A second and related problem is that there is no accepted and inclusive vocabulary which one may apply to the functions of systems: (a) to provide functional equivalents (translations) among the concept-patterns of traditional disciplines, and (b) to facilitate the development of nomenclature

for new territory. (6) (7) For this reason, problems frequently appear as difficulties in quantification, rather than as a lack of useful functional descriptions. Solutions to quantification problems that do not have their origin in functional descriptions frequently lead to the application of invalid criteria. (8)

A system is described in terms of its purposes. Reference to the origin of a set of purposes usually makes it apparent that a given system is in fact a subsystem of a larger system. In discussing military systems, the largest reference group may be set at the national level. However, in this country, there is no "single top", and we may therefore be discussing a more or less integrated aggregate of systems, most of whose boundaries, functions, and inter-relationships have never been identified. (9) Even so, it is at this point that "systems concept" as a technical term begins to apply. A system is defined as "a group of components designed to serve a given set of purposes... a set of purposes is called a mission". (10)

Another way of describing a system is by its development along a time line. The stages of the system research process are by now fairly well defined operationally, though terminology and emphasis vary from one research group to another. (3) (11) (8) (12)

Generally these stages are:

1. Requirement setting: delineation of system performance requirements.

2. Design Guidance: derivation of design consequences.

3. System Development: development and integration of the system.

4. System Evaluation: evaluation of system performance in terms of the requirements.

Each of these stages is constrained by those preceding, and every current decision, within and between stages, should represent a further implementation of prior decisions. (3) The problems in methodology that were noted by 1961 indicated that the criteria for this decision series were neither systematic, nor in many cases explicitly stated. This will be apparent in the following list proposed in 1961. (13)

1. The need for systematic methods for deriving design guidance, (i.e., configuration), from detailed requirements.

2. The need for a theory of allocation of system functions between man and machine.

3. The need for an integrated set of criteria, representative of each stage and applicable to operational testing.

In effect, the third of these identified "needs" would subsume the first two, and it is clearly

labeled "criteria".

Also, at this time, it was noted that "while there has been research and theoretical formulation of combat systems at the strategic level, and.... research at the operational level, there has been relatively little conceptual formulation that could lead to a coherent and comprehensive theory of combat at the tactical level." The tactical level is defined as that at which both system and enemy are interacting in a specific combat context. (The strategic is the command level, and the operational level refers to intra-system operation without reference to an enemy.) In the identification of these needs, the human operator is described as a "system manager", and the human factors engineering task is seen as one of defining, early in the development of the system, the tasks of the system manager, and the related informational requirements. (13)

Conclusions of this study effort were that the nature of the operator's judgmental processes have become critical, as have the nature and characteristics of information and its relationship to features of equipment design. Specifically it was concluded that the critical need areas in systems development are:

1. A more adequate treatment of the logic involved in the specification of system requirements. (This appears to refer again to the lack of a general tactical theory of combat, and intimates that if the systems developer knew more of the processes by which the system user translated tactics into system requirements, he might be better able to fulfill those requirements.)

2. A better task taxonomy.

3. Integration of data on human capabilities in a form more usable for design.

4. A more detailed development of information characteristics and their relationship to display and control design.

5. Further exploration of the value of using operator decisions as one basis for specifying information requirements for heirarchical futuristic systems.

6. Specification of criteria appropriate to task allocation between man and control devices within the control systems---that is, a means of predicting reliability of mission accomplishment with various allocations of tasks.

7. More adequate examination of the implications of providing a consistent frame of reference for display design. (13)

These, then, are need areas which were recognized in this form by 1961; the list has been presented in detail in order that it might serve as a frame of reference in which to consider later systems development

problems of criteria.

We will now consider a differently oriented approach to criterion problems.

In 1961 Story (14) suggested that there are four basic approaches to the evaluation of man-machine systems and postulated the four categories of criteria which apply. These are:

1. Materiel--criteria used to evaluate the physical components, human or machine.

2. Mechanistic--criteria applied in the evaluation of functional relationships within the system.

3. Logical--criteria for evaluating consistency or coherence of the system performance.

4. Final--criteria for evaluating the systems goals achievement: mission accomplishment.

These criteria are tightly interrelated in a functioning system, but the order above is roughly applicable with regard to both the complexity and the development of a system along a time line. Story's hypothesis was that problems of design and evaluation can be expressed as the establishment of relationships which obtain among the above categories of criteria. Research studies, relating to system development, were examined in order to classify the reported criteria in terms of the postulated categories. It was found that the reports examined did not provide explicit structured data on the man's role in the operation and maintenance of the system. Other findings were: the categories of logical and final criteria were most numerous in the literature on systems development as compared to the mechanistic or materiel categories. Also, that logical criteria seem to be of most interest to design engineers, while mechanistic and final criteria seem of most concern to program managers and system evaluators. Particular note was taken of the difficulties introduced by the use of simulated systems, (e.g., computer war games), or of simulated input. The validity of simulation criteria may be uncertain because: (1) The difference between real and simulated input-output may be so great that though the system appears to be operating, it is functioning differently than under real conditions, or (2) at the management decision level, there may be problems in establishing boundaries: if the boundary between the input and the system is set too far in, one would expect interference in initial or terminal system processes, resulting in a truncated system or subsystem.

During this same period (15), it was noted that the operations research analyst was not only interested in measures of total system effectiveness, but was interested primarily in those which could be expressed in dollars. The criteria used in lab studies (from which most human

factors data comes) are usually immediate measures, under controlled conditions, of time and error. The applicability of this data must be determined in the light of all the other constraints which obtain in a given systems context and which form the basic criteria on which trade-offs must be made. Only ideally can the following conditions be met:

1. There is no threat to basic physiologic functions.

2. The recommended hardware has a total cost (manufacture, installation, maintenance) less than or equal to that rejected.

3. The recommended hardware is compatible with the rest of the system.

4. The relevance of the task (being modified by a change in hardware configuration) to system mission accomplishment is clear.

A notable example of departure from this ideal may be considered:

1. A given aircraft must be pressurized to 14000 feet to maintain optimum pilot environment.

2. It is desirable to reduce costs, increase payload, etc., as much as possible.

3. What will be the effect of pressurizing to only 12000 feet?

In an attempt to make the effects of anoxia on pilot performance quantifiable in terms of mission accomplishment (15) it is clear that the problem is one of somehow calculating the negative value of human factors engineering. How can one account, in terms of either mission relevant performance, or of dollar cost, for the effects of a less-than-optimum environment?

The quantification of human performance, even without the necessity for calculating its monetary value, is very complex. Wechsler (16) has said, "The problem boils down to this: in what way must we define our terms to give unequivocal meaning to our judgments, and, more particularly, to make valid comparisons. They must be capable of numerical definition"... "The various attempts at transmuting qualitative estimates of difficulties and excellence of performance may be reduced to three methods or procedures: first, the method of expert opinion, at once a starting point and a final criterion of difficulty or excellence. It cannot be replaced by statistical methods, but only refined by them. Second, the method of inverse frequencies: the excellence or difficulty of a task is some inverse function of the frequency with which it is successfully performed--the assumption being that success and failure are determined by degrees of ability. Third, the method of psychophysical correlation: the unit of sensation (Just Noticeable Difference (JND)) plotted against actual measurements of the physical source of

stimulation--the resulting equation gives the permanent definition of the final units. It is assumed that such differences are equal to each other at any point in the scale at which they are perceived." (The processes measured are the simpler mental functions of sensation and perception, at least thus far.)

"Human abilities and traits are measurable to the extent to which they may be expressed in terms of or as functions of the basic units of physics or their derivatives, and comparable to the degree to which they lend themselves to such measurement. This is possible (now) in the case of all physical measurements, (anthropometry), most physiologic and metabolic functions and a small number of psycho-perceptual traits and abilities." It does not yet obtain in the case of most abilities termed "mental" or intellectual. (16)

In 1957 (6) attention was drawn to the fact that "in many circumstances the behavior of the man was inseparably confounded with that of the mechanical portions of his environment...all along psychologists had been studying the behavior of man-environment systems, and not that of the men alone." It was being emphasized that psychologists would need to know something of the nature of mechanical-environmental constraints in order to establish appropriate controls in their experiments on performance.

There is a tremendous amount of data on human performance which has accumulated over time; however, the application of this data in the development of any given system is not always clear. One method of solving this problem has been to turn to behavioral investigation of the performance of the system itself. Because of its size and complexity the system cannot usually be manipulated directly, therefore, some representation of the system is built, and its operation examined, in order to better understand the interrelation among system variables. "Model" is a term used in various contexts to mean math model, computer war game, dynamic or static mock-up flow-chart, etc. (17)

Work on models has been intensive for the last 10 years or more. The advantage of a successful model is in cost and convenience, and particularly its usefulness in general application to system design. If parameters of a system can be represented for manipulation, and if an "optimum" solution can be validated empirically, then the terms of that solution may generalize to other systems.

One of the most interesting concepts of the nature of a usable model was that of the "self-organizing system". These models were often defined by reference to the formal descriptive mechanisms outlined by Ashby on Homeostasis, Waddington on

epigenetics, and Weiner on cybernetics. (4). Since the initial selection and weighting of parameters is so liable to serious error, (18) (19), it was hoped that the relationships among functions found to obtain in self-organizing systems would provide criteria relevant to the development of a general systems theory. Even if the workings of this self organizing system were not obvious, (as the operation of the human decision making process is not obvious), so that it did not contribute directly to the development of theory, a self organizing system might be of aid in the efficient solution of problems involving inherently non-numerical types of information. These would includ^ for instance, automatic print reading, speech recognition, automatic language translation, information retrieval, and control of large and complex systems. (20) Many of the ideas and techniques advanced in this area represent radical departures from tradition, and it is not yet possible to evaluate their possible impact.

The problems inherent in building and using models as an aid in the design and evaluation of systems have received increasingly explicit attention. From the development of requirements to the evaluation of the completed system, it is apparent that the terms and concepts employed are themselves aspects of often implicit models. The constructs on which value judgments are made at various stages of system development should be examined and recorded in so far as this is possible. This observation has been made by economists and management theorists, by psychologists and engineers, and by mathematicians concerned with systems development. We do not now have a model that can deal effectively with non-numerical data. The development of such a model might reasonably begin with an examination of present decision patterns and their contexts.

CURRENT DEVELOPMENTS: A SUMMARY

The problems of criteria which are recognized in 1967 are not basically different from those noted by researchers at the beginning of this decade. Approaches to solving these problems have evolved in the direction of making their parameters more explicit by: first, recognizing the interdependence of "factors" extrapolated from the classic problems of measurement:

a) of physical systems
b) of human performance
c) of the performance of systems as economic entities.

Secondly, in attempting to standardize the conditions for interpolating the judgment of experts at critical points in systems development. (21) (22) (23) (24) Finally, in the increased recognition of the inadequacy of the data which relates to the smallest elements of the system that can be identified, i.e., items of

hardware, units of vehavior and some "utile" measure in dollars in light of the general recognition that system development appears to be elementaristic.

In this connection it should be noted that more sophisticated techniques are being brought to bear on the problems of dealing with the massive quantities of data necessary to the development of a system. It has been suggested that the "really expert programmer" should be made a full member of the design team. (5) Data stores are being constructed which attempt to organize units of behavior in a coherent task-hardware-response format so that performance data may be made available in a form more applicable to systems development. (25) (26)

A comprehensive and continuing task has been undertaken to collect all the pertinent studies in human factors research. (27) The problems of developing a coherent and flexible retrieval system for this source holding relate directly to those problems noted by research teams from 1958-1961. It was noted then that every conceptual innovation, every new category of discovered relevant material, forced a complete reorganization of the library.

We have discussed:

1. The relevance of valid criteria for systems building.

2. The necessity of models to represent various system functions in order to facilitate an over-all understanding of the relationships among system variables.

If adequate systems relevant criteria are to emerge from the modeling process quantitative data must first be entered in the model. In the current state of the art, where human performance data is not already available in applicable form it must be generated for the system as it is developed.

It is apparent that progress for the past decade has been in small steps, related to specific problem areas as they have been identified. Thus we are increasingly equipped to handle more data at a time; to secure and consider this data earlier in the development process; and to integrate our rationale for systems effectiveness more smoothly from earliest stages through final product testing.

Systems can be built. It remains to determine whether they can be operated in the environment for which they were designed and at what level of performance and reliability. We have barely begun the building of a theory of systems which would contain an integrated set of criteria.

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6B. MISSION-RELEVANT PERFORMANCE CONSIDERATIONS IN EQUIPMENT DESIGN

Russell M. Phelps, Captain, USA
U.S. Army Human Engineering Laboratories
Aberdeen Proving Ground, Maryland 21005

The military environment differs from the civilian atmosphere in which equipment is usually developed; the emotional stresses of combat, the regimen of military discipline, and the rapid turn-over of personnel are just a few of the differences that exist. Because of this divergence, there is a problem in insuring that civilian-developed military equipment will operate successfully when used by military personnel in the spectrum of tactical environments. To solve this problem, the civilian contractor requires guidance from the military to help produce the best design. This guidance can come in various forms and from a variety of sources. One form of guidance, mission-relevant performance considerations, whose principal source is field experience, is the principal topic of this paper.

As mentioned previously, there are many forms of guidance generated by the various Army agencies. These include such factors as specific performance parameters, doctrine, and concepts of employment. These might come to the contractor in the form of Military Specifications, Qualitative Materiel Requirements, Combat Developments Command studies, or other such documents. Mission-relevant performance considerations, however, by definition are usually not incorporated within those documents. Mission-relevant performance considerations take into account those finite aspects of the military environment, known only through experience, that have so far escaped the standard forms of guidance but nevertheless exist within the military system.

Perhaps the best way to define the term is to show how mission-relevant performance considerations are incorporated into equipment evaluation at the U.S. Army Human Engineering Laboratories (HEL), where field-experienced military personnel are used toward this end. An example analysis performed by a user (military Personnel)-human engineer team will also tend to point out some of the benefits and restrictions of this form of guidance and its source.

EXAMPLE SOURCE

One of the missions of HEL is to help designers integrate human engineering concepts and principles into weapons system development -- where the term weapons system refers to the whole spectrum of Army equipment, encompassing not only weapons per se, but also communications equipment, vehicles, and a variety of other gear.

To help the human engineering specialists at HEL accomplish this all-important mission, field-experienced military personnel, both officers and non-commissioned officers, are included in the organizational structure. These individuals work directly with the human engineering specialists, forming a user-human engineer team. The military personnel fulfill their principal role in the team by providing a source of mission-relevant performance considerations through their background experience. They also, at times, serve a secondary function as the on-duty expert on current doctrine and concepts of employment, as will be pointed out in the example analysis.

EXAMPLE ANALYSIS

To further define the term 'mission-relevant performance considerations' and to show some of the benefits and restrictions placed on such considerations when generated through field experience, a prime example is the human factors analysis recently completed by a user-human engineer team from HEL on the Central Office, Telephone, Semi-automatic, AN/TTC-15. This equipment is currently under development by the Random Access Discrete Address/Tactical Automatic Switching (RADA/TAS) Project Manager's Office. Although all aspects of the AN/TTC-15 were considered in the actual analysis (to include shelter configuration, environmental conditions, maintenance considerations) -- the example analysis will only discuss those performance considerations related to the switchboard front panel, since the inclusion of the other aspects of the AN/TTC-15 would be mostly redundant examples and would require considerably more time to discuss than available for this session.

The AN/TTC-15 is a manually-operated, cordless switchboard which permits interconnection (switching) of 40 local or trunk, 2-wire or 4-wire, telephone circuits, and is presently configured for mounting in a $1\frac{1}{4}$-ton S-250 shelter (1). It is planned to be used either singly or in pairs, expanding its capacity to 80 circuits. Figure 1 shows the switchboard front panel as it originally was presented to HEL for a human factors analysis. The front panel can be broken down into three sections according to their physical relationship:

a. The vertical section which includes shelves A through D.

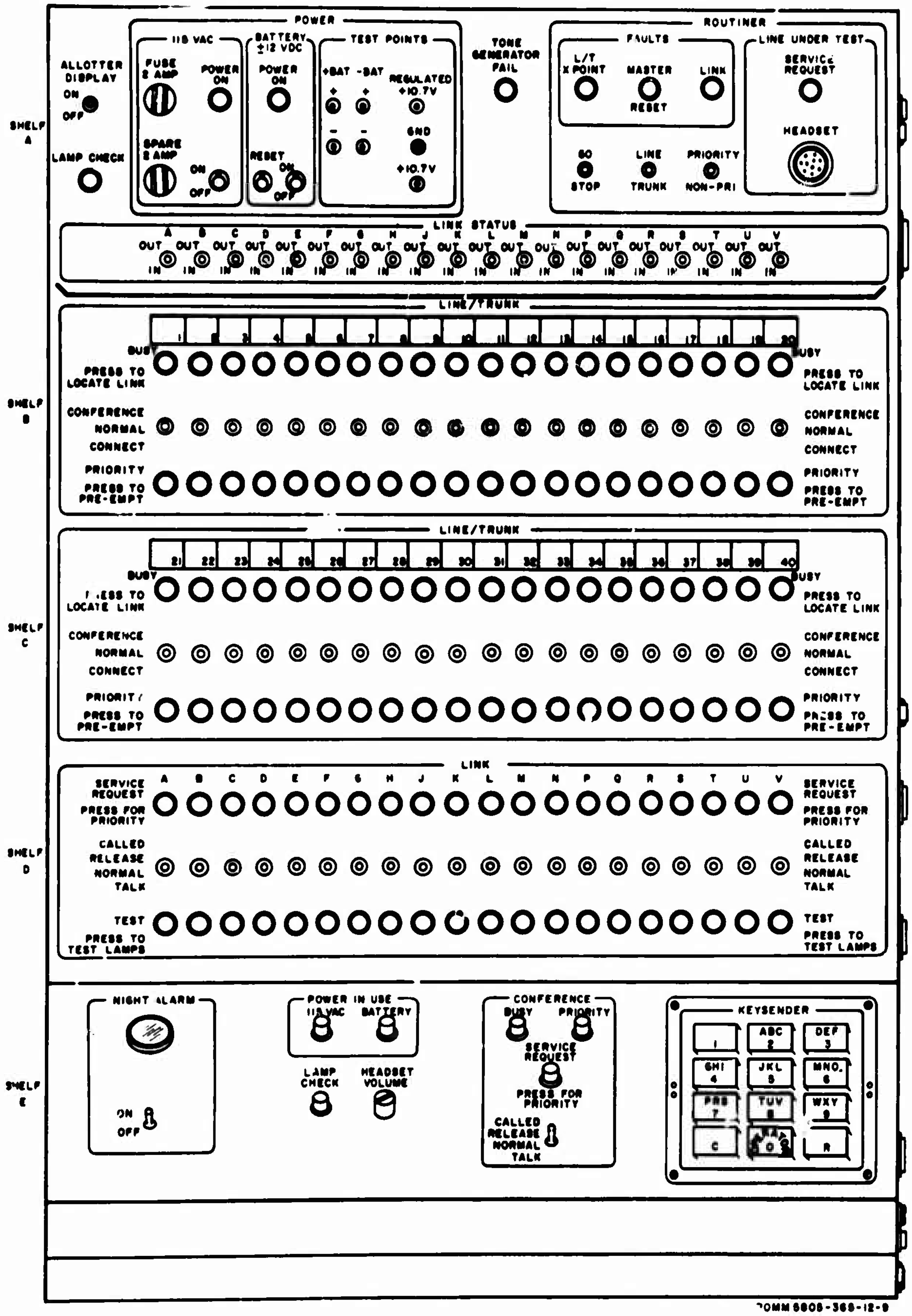


Figure 1. Original AN/TTC-15 Switchboard Front Panel

b. The slope section (shelf E) which is angled at approximately 42 degrees from the vertical.

c. The horizontal section which extends out from shelf E to act as a writing shelf upon which the switchboard attendant may also rest his arms.

Figure 2 shows a mockup of the switchboard front panel after the HEL human factors analysis. Because of design restrictions the overall height and width of the front panel were not changed- yet several new functions were added, while still allowing 14 inches at the top of the vertical section for an information display. A few of the changes were brought about by the contractor and the PMO which do not show on the original front panel, and include:

a. The auto link switch and associated auto/manual switch.

b. Master Pre-empt switch.

c. Link finder (previously called allotter display but now incorporating added functions).

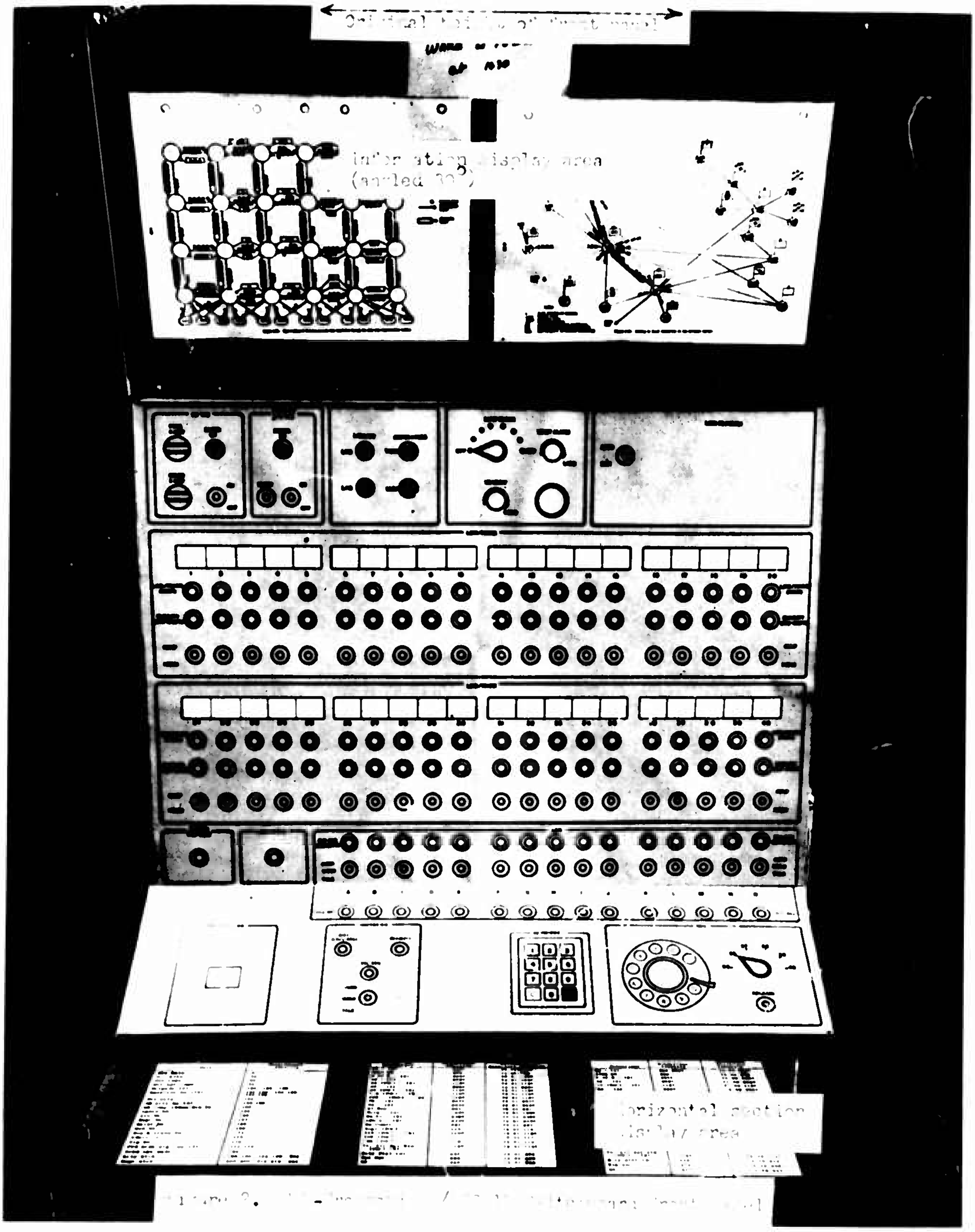
d. Three new alarm indicators: line lockout, link lockout, and 20 Hz generator fail.

Also new to the HEL-proposed front panel is the dial group which originally was attached to the main distribution frame.

Apart from these differences, all of the other changes involved incorporation of human factors criteria and mission-relevant performance considerations generated by the user-human engineer team which worked on this example analysis. Some of these changes and the method of approach to them will be discussed to point out the advantages and restrictions to performance considerations gained through field experience.

A. Background Study

Two individuals, a human factors specialist and myself, of the Missile/Communications Branch of the Systems Research Laboratory, HEL, undertook the analysis. In this case, there had been no previous studies concerning switchboards within the Human Engineering Laboratories, so that any human factors specialist assigned to work on the project would have to start from the bare fundamentals to gather a comprehensive understanding for the switchboard and its environment. The human factors specialist, however, was in a position to provide specific data relative to reach distances, locations of primary and secondary control and display areas, hardware considerations, and other technical areas. Additionally, he assisted in the mockup preparation, review and evaluation from the standpoint of anthropometry, visibility, accessibility of controls, and control design. What he did lack was the experience to efficiently apply this technical knowledge. This is where the second individual comes in, a Signal Corps Officer with six



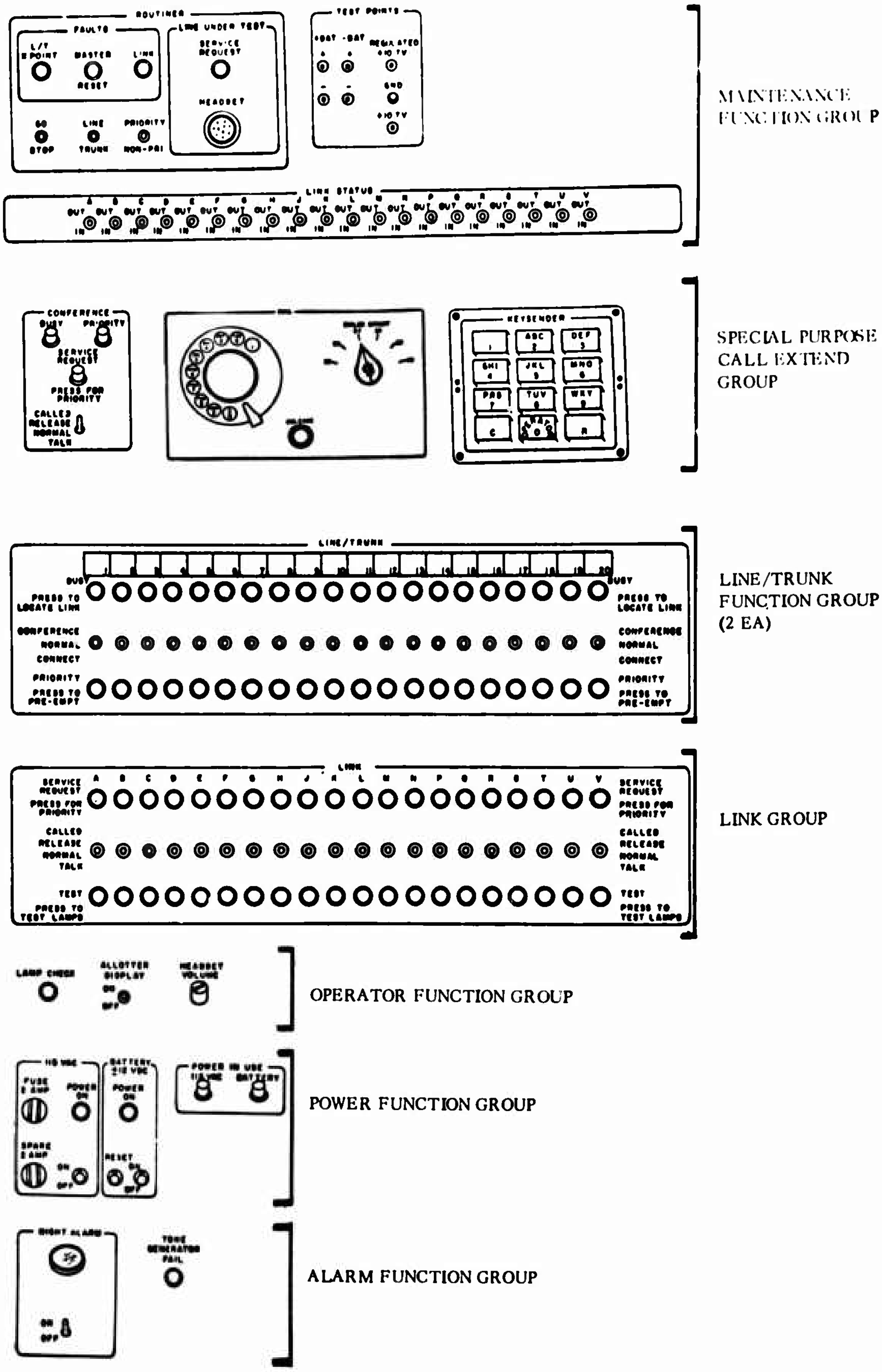


Figure 3. FRONT PANEL FUNCTIONAL GROUPS, LESS ADDITIONS

years of field experience that included direct experience with the various problems associated with the current inventory of manual switchboards employed by the Army. When it came to studying the operating task of the switchboard personnel, the method of employment and the communications environment in which the AN/TTC-15 would exist, this communications background and experience provided a quick grasp of operational details and concepts (thus showing how field experience can aid in shortening the time required for background study requirements).

B. Functional Grouping

In studying the layout of the switchboard and contrasting it to the various operator tasks, it was noted that there was extensive travel of the operator's hands, because prime control/display areas were sometimes being used for secondary functions. To eliminate this, the front panel display (Figure 1) was divided into functional groupings (Figure 3). Each group and items within the group were then assigned a relative priority for location on the front panel. These relative assignments were based primarily on my recent experience as the Traffic Engineer of the Saigon Telephone Management Agency. In this case, definite traffic analysis data were not readily available, so field experience was used to predict a relationship of traffic priorities (mission-relevant performance considerations) to set the functional group in proper perspective. The assignment included the following points:

1. Through the study conducted of the operator and maintenance tasks, it was determined that the maintenance functions placed on the front panel served no particular purpose during operations and should be placed at the rear of the switchboard, which is the principal maintenance area. This helped not only to centralize maintenance, but also freed space on the front panel.

2. Each time a call is placed, the link group is used. Each time a call is extended, the line/trunk group is used. Because of these factors, and the fact that the link group is the primary monitor area, the link group was given the highest priority, with the line/trunk groups following second.

3. The special purpose call extend group was given the next highest priority, not because the three functions within this group are all equally important in all situations, but because at least one of the functions is always important. The particular function which has the importance is dependent upon where the switchboard is located in the communication system. If the switchboard is located within a completely manual switchboard area, the conference group will be used more than the keysender or dial. If the switch is located on the edge of the TAS conceptual area, then the keysender will be used extensively as the entry mode

into the automatic system. Similarly, the dial group might be used quite frequently since the two wire version of this switch is programmed for employment in SEA, where an extensive dial network is presently being installed. What we have then, is three different communication situations that might exist and which serve to point out the variable relative priorities for three functions. Again, field experience helped to determine these relative priorities or mission-relevant performance considerations.

4. The alarm, power, and operator groups, because of their infrequent usage, were given the lowest priority.

C. Information Display Area

A point noticed from past experience was that the AN/TTC-15 switchboard front panel left no space for information displays except by taping the necessary documents to the horizontal section. The operator would be required to refer to this information display for such items as trunk routing diagrams, local directory listings, and dial and/or keysender number listings when appropriate. Considering the TAS concept in which the AN/TTC-15 will be employed and considering the quantity and size of the documents that must be displayed, the horizontal shelf section (6 3/4"x 24") was far too small. In order to provide a neater display area on the horizontal shelf section, a plexiglass cover was added.

Additionally, a second display area was provided in the top portion of the vertical section. This was achieved through the removal of the maintenance functions mentioned earlier and a reduction in height of the sloped section. These changes involved not only field experience which identified the performance consideration problem area, but also used the results of the basic background study (mentioned earlier) to determine the scope of the problem; i.e., the display area size necessary to meet the requirements.

D. Line/Trunk and Link Grouping

In the HEL-proposed front panel the Line/Trunk and Link switches were grouped into quantities of five. This change was brought about through knowledge of how existing small switchboards of this nature identify subscribers. From past experience, it was noted that subscribers are sometimes designated by their switchboard drop; i.e., drop #1 is always the adjutant, drop #2 the intelligence officer, and so forth. By splitting the switch groups into sections of five each, instead of 20, the search time of the operator in extending a call is reduced.

This example tends to bring to mind one of the restrictions in using performance considerations generated through field experience. Caution must be taken to insure that the problem area being covered by the performance considera-

tion is not in fact an improper practice which requires emphasis in another area, such as training or discipline, and not a change in design. For instance, if I had suggested providing a spot for the attendant's coffee cup, this would be an incorrect consideration, since beverages are generally not allowed inside signal shelters because of the damage they might do if spilled on the equipment.

E. Function Designation

Investigation of the labeling of the various controls and indicators on the front panel showed that some of the labels, although accurately defining the corresponding control or indicator, could be simplified in wording. Two such labels were "Queue Advance" and "Dial Applique" which were changed to "Call Advance" and "Dial" respectively. The original labels are quite appropriate to the technician or engineer working on the equipment in development, but to the average soldier whose education level would be, in most cases, much lower, these terms should be simplified while still conveying the meaning.

EXAMPLE ANALYSIS SUMMARY AND CONCLUSIONS

The HEL-proposed changes to the front panel mentioned above are just a few of the many incorporated. Only those changes that helped to demonstrate the particular characteristics of mission-relevant performance considerations were mentioned. Those changes mentioned, however, tend to point out the benefits and restrictions of performance considerations gained through field experience and at the same time serve to define the term 'mission-relevant performance considerations' through example. As of this writing, the HEL-proposed version of the switchboard front panel has been inspected by both the contractor and the PMO and except for minor revisions, has been accepted as final design.

Besides the benefits derived from the input of mission-relevant performance considerations to equipment development as shown in the example analysis, there is another more subtle advantage gained in having field-experienced military personnel work directly with human engineering specialists. In a sense, the experiences and knowledge of both are exchanged through this working relationship and both members profit from it. The military personnel come away having a more thorough understanding and appreciation for the effort that goes into equipment development. The human engineer, on the other hand, receives a continuous up-dating on the trends of the military environment because of the constant turn-over in military personnel assigned to these laboratories. For these reasons, the user-human engineer working relationship must be considered as one excellent method of approach for insuring that mission-relevant performance considerations are included into equipment design.

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6C. HUMAN PERFORMANCE RELIABILITY – MEASUREMENT AND PREDICTION IN SYSTEMS OPERATION

H. L. Williams
Martin Marietta Corporation
Orlando, Florida 38205

Summary

The measurement and prediction of human performance reliability is a necessary part of the design, development and utilization of a weapon system. An investigation into methods for doing the job, however, reveals the existence of a serious problem generated by the dependent relationships among steps in a task performed by a single individual or by individuals working together. Probability models can be constructed without difficulty for computing performance reliability where a dependent relationship exists. The problem arises when one attempts to secure values for use in the model. The value of each term in the dependent model is unique, and for this reason cannot be found in a data store or other source of human reliability data. Thus, a serious problem confronts the analyst attempting to evaluate human performance reliability where a dependent relationship exists. He must evaluate human performance reliability in order to properly design, develop and utilize a weapon system. Yet, he has no available source of fully relevant data.

It is suggested that the problem can be solved by the development of a model for making the transition from the probabilities found in the data stores to those of the dependent model. It's form is similar to the linear model of experimental statistics. Work is needed, however, before terms for this model can be established. The factors responsible for the dependent relationship must be fully identified, and studies must be conducted to obtain values for parameters in the model. Success or failure in the development of the transition model ultimately may depend upon the number of interaction effects occurring among the factors responsible for the dependent relationship.

INTRODUCTION

Many operating and maintenance tasks can be performed by either man or equipment. Decisions reached in making a task assign-

ment must take into account the effectiveness of both. A close look at established methods for the analysis of man's role in a system, however, reveals that there is little available information about how to do the job. Historically, the established methods of human factors engineering require that tasks be assigned to man and machine on the basis of ability to excel in their performance. In most instances human factors engineers have been content to define effective human performance as the ability of an operator to perform assigned tasks with a specified accuracy, rate of other criterion. It is well known, of course, that a man often will fail in the performance of a task which, in terms of a criterion such as accuracy, etc., he is fully capable of performing. However, this lack of performance reliability seldom is taken into account, even though it may be an important measure of human performance. The objective of this paper is to inquire into the problem and to determine how one should go about the measurement and prediction of human performance reliability.

THE APPROACH

Measurement and prediction of human performance reliability can be of value in all phases of weapon system design and development. In the concept stage it can be used as one of the criteria for the selection of the best of alternative system concepts. During design and development it can be used as a measure of adequacy of system and equipment design. When a system has been fielded, it can be used in mission planning to help establish the quantities of men and material needed to accomplish given objectives.

During the concept stage, actual equipment and personnel are seldom available for purposes of testing. Comparisons of alternatives are made primarily by means of paper-and-pencil analyses. Steps performed in these analyses are as follows:

1. Definition of mission requirements which includes the identification of mission objectives, determination of anticipated use environments and mission success criteria, and specification of any other information defining the use conditions of the system.

2. Determination and description of tentative system and equipment design features for each concept, the primary objective of which is to establish the characteristics of the operator-equipment interface. Since the interface includes both operators and equipment, the system description likewise must cover both.

3. Preparation of hypothetical operating procedures, arranged as discrete steps of operator tasks that form the basis for elements in the probability models. Therefore, in preparing hypothetical operating procedures for the system concepts being evaluated, one lists procedural steps, along with sufficient descriptive information to permit probability-of-success estimates to be made.

4. Construction of probability models, which starts with construction of models for subtasks. The outputs from these models are then combined into models representing several subtasks. Outputs from the combined models are in turn combined at progressively higher levels until a model is obtained that represents performance of the total task.

5. Estimation of values for terms in probability models. The approach for estimating probability values for independent events differs considerably from that for estimating dependent probabilities. If the terms in the model are independent, one may estimate the value for a given term without concern for other steps in the operating procedure. In contrast, if the terms are dependent, one must consider earlier steps in the procedure when estimating the value of a given probability.

6. Computation of human performance reliability, which proceeds in accordance with the mathematical relationships set forth in the probability models.

Steps in the procedure for estimating human performance reliability during design and development are essentially the same as those used during the concept stage. The concept is fixed by the time the system enters design and development. Alternatives to be considered and evaluated now are limited to system and equipment design features. Human performance reliability is one of the measures used for comparing alternatives and arriving at an optimum design.

During the utilization stage when the system has been fielded, estimates of human performance reliability are needed for mission and logistics planning purposes. Design features of the system and equipment are no longer tentative. Operating procedures are firm. If adequate test and field data are available, the step-type procedure outlined above is not used. One obtains the necessary estimates from the test and field data by taking the ratio of operator successes to total number of tests or trials. If adequate data is lacking, however, human performance reliability must be computed, using essentially the same procedure as that used in the concept and design and development stages.

The Problem of Dependent Events

In the measurement and prediction of human reliability system, the assumption is often made that steps in a task are independent. This assumption may not be valid for steps in any task performed by a single operator are dependent. Dr. David Meister (1), for example, in discussing the problem makes the following statement:

> "The use of the product rule assumes that the performance of each element is independent of the performance of other elements in the task. In view of the overwhelming psychological research evidence about the interdependence of behavioral variables, one can hardly accept this assumption.

Multiple interaction is particularly characteristic of system operations. In some cases the interactions of preceding and succeeding elements result in significant changes in either direction from a hypothetical "average" error rate. For example, an access cover cannot be removed until the lockwire, bolts and washers have been removed. If the mechanic forgets to remove the lockwire, he is unlikely to be able to remove the cover and so will tend to remember and reverse this error during succeeding steps. Interaction may also effect an increase in error. A mechanic may be required to remove a protective cover from a port before connecting a cable to that port. If the wrong port is uncovered, the probability of connecting the wrong cable is increased. A comprehensive study of interaction (particularly in the system content) is needed to facilitate accurate determination to its effect on the reliability of performance. Therefore, the utilization of a probability model that assumes element independence must be considered only as a temporary expedient."

One hesitates, of course, to employ methods which may be in error and which invite such criticism. Therefore, if the measurement and prediction of human performance reliability is to become useful and commonplace, a solution must be found to the problem of dependent events.

Effect of Dependent Events

To illustrate how dependent events can affect the probability of task success, it is helpful to examine an experiment conducted by Buckner and McGrath (2). In their experiment it was established that the probability of detection of a visual-type signal on a display was 0.86. The probability of detecting an audio signal from the same source was found to be 0.76. If the audio and visual channels are independent, one would expect the probability of signal detection, P_d, using both channels simultaneously to be

$$P_d = 1 - (1-0.86)(1-0.76) = 0.97 \quad (1)$$

However, Buckner and McGrath found the actual probability of signal detection using the visual and audio channels simultaneously to be only 0.91, a value significantly different from 0.97.

In the Buckner and McGrath experiment (2), the audio and visual channels were used simultaneously. Under these conditions, lack of independence is not surprising.

An equally obvious case of event dependency among steps in a task occurs when the probability of success in the performance of a given step is a function of the time taken to perform earlier steps. This may be shown by considering a two-step task where the time available for the perfor-

mance of the task is limited to a constant value, k. Performance times for the two steps can be expressed as follows:

$$t_1 + t_2 = k, \qquad (2)$$

where t_1 is the time taken to perform step 1 and t_2 is the time taken to perform step 2. Because the time available is limited to k, the value of t_2 must decrease as t_1 increases. If t_1 is permitted to approach k, then t_2 must approach zero. Obviously, as t_2 approaches zero the probability of successful performance of step 2 likewise must approach zero and thus dependency is established.

Success and failure in a task are also affected by such attributes as accuracy of control, amount of force applied, perception of information, etc. Therefore, in considering the dependence of success or failure in one step upon another, one must examine the effect of these success and failure attributions in one step upon similar attributes in another. If, for example, the amount of force applied in order to achieve success in one step leaves the operator fatigued, then success or failure in the following step is dependent upon success or failure in the first. On the other hand, an effort less than that required for success in one step might increase the probability of success in the following step. Relationships between other attributes likewise can be established, and in the case of the human a sufficient number of such attributes are always present that one must assume the existence of an effect of one step upon another when performed by the same operator.

The effects of dependent events need not always result in a lower probability value as was found in the Buckner and McGrath experiment. If equipment used in performing a task is designed to establish the right mental set, state of alertness or favorable mental or physical condition in the operators, performance reliability may actually be higher than that computed under the assumption of independent events. Improper design of equipment, in turn, may excessively degrade performance reliability.

Definition of Statistical Independence

In discussing methods of computing human performance reliability under the assumption of dependent events, it is helpful to first define the conditions for statistical independence. Two events, X_1 and X_2, are said to be independent in the probability sense if either of the following relationships is satisfied (3):

$$P(X_2, X_1) = P(X_2) \qquad (3)$$
$$P(X_1, X_2) = P(X_1)\, P(X_2) \qquad (4)$$

If X_1 represents success in step 1 of a two-step task and X_2 represents the same for step 2, equation (3) in words may be stated as follows: The Conditional probability of success in step 2 (given that step 1 has been suc-

cessful) is equal to the marginal probability of success in step 2. Thus, if steps 1 and 2 are independent, success in step 2 is not affected by step 1. Equation (4) states that the probability of success in both steps 1 and 2 is equal to the product of the marginal probabilities of success in steps 1 and 2.

If $X_1, X_2, \ldots X_n$ represents successful performance of steps 1, 2 ... n of an n - step task, general relationships for independence of events in a series task may be stated as follows:

$$P(X_n | X_1, \ldots X_{n-1}) = P(X_n) \quad (5)$$

$$P(X_1, X_2 \ldots X_n) = P(X_2) \ldots P(X_n) \quad (6)$$

The variates $X_1, X_2 \ldots X_n$ may be used to represent either success or failure in the various task steps. If this is done, equations (5) and (6) define the conditions for statistical independence of the various possible combinations of success or failure in the n steps.

Treatment of the conditions for independence of task steps in parallel require a somewhat different approach. Assuming that all steps of an n-step task are in parallel, only one of the n-steps must succeed in order for the task to be successful. Stated differently, the task will be successful if failure does not occur in all n steps.

To illustrate the model for independent, parallel steps, let

$X_1 = 1$ denote success in step 1

$X_1 = 0$ denote failure in step 1

$X_2 = 1$ denote success in step 2

$X_2 = 0$ denote failure in step 2

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$X_n = 1$ denote success in step n

$X_n = 0$ denote failure in step n

Then the probability of task success, P_s, is given by

$$P_s = 1 - P(X_1=0)P(X_2=0) \ldots P(X_n=0) \quad (7)$$

Probability Models Based on the Assumption of Dependent Events

In defining the conditions required for statistical independence of events, equations (3), (4), (5) and (6) also indicate the approach that must be taken in deriving probability of success models where steps in a series task are assumed to be dependent. For example, in a task composed of two dependent steps, the probability of success in step 2 is given by the conditional probability, $P(X_2|X_1)$. From elementary probability theory (3) we know that

$$P(X_2|X_1) = \frac{P(X_1, X_2)}{P(X_1)} \quad (8)$$

and

$$P(X_1, X_2) = F(X_1)P(X_2|X_1) \quad (9)$$

Thus, in a two-step task the probability that both steps are performed successfully is equal to the marginal probability that

step 1 is performed successfully multiplied by the conditional probability, $P(X_2 | X_1)$.

For an n-step task where steps within a task are dependent, the probability that all n-steps are performed successfully is given by

$$P(X_1, X_2, \ldots X_n) = P(X_1)\, P(X_2 | X_1)\, P(X_3 | X_1, X_2) \ldots P(X_n | X_1, X_2 \ldots X_{n-1}) \quad (10)$$

It should be noted that if the X_i, i=1, 2 ... n, are defined to be successes, all factors on the right-hand side of equation (10) except the first represent the probability of successful performance of a specific task step, given that all earlier task steps have been performed successfully.

If the variates $X_1, X_2, \ldots X_n$ represent either success or failure in performing the various steps, equation (10) becomes the general probability model for computing the probability of occurrence of any given combination of success and failure in the n steps in series under the assumption of dependence of events.

The effect of dependence among task steps in parallel can be shown by considering a two-step task in which an operator turns off the power to an equipment and then disconnects the power cable. Either operation will remove power from the equipment. However, let us assume that experience with the equipment has shown that if the operator forgets to turn off power, he is likely to forget to disconnect the power cable. In other words, the two operations are not independent. We proceed in this instance by first determining the probability, Q, that power is not removed from the equipment. For this purpose, again let

$X_1 = 1$ denote success in step 1
$X_1 = 0$ denote failure in step 1
$X_2 = 1$ denote success in step 2
$X_2 = 0$ denote failure in step 2

then,

$$Q = P(X_1 = 0)\, P(X_2 = 0 | X_1 = 0) \quad (11)$$

The probability of success, P_s, is given by

$$P_s = 1 - Q = 1 - P(X_1 = 0) P(X_2 = 0 | X_1 = 0) \quad (12)$$

For n operations in parallel, the probability of success is given by

$$P_s = 1 - P(X_1 = 0)\, P(X_2 = 0 | X_1 = 0) \ldots P(X_n = 0 | X_1 = 0, X_2 = 0, \ldots X_{n-1} = 0) \quad (13)$$

Returning to equation (10), it will be noted that this model has the same general form as the series probability equation for independent events (Equation 6). Only the values of the probabilities for individual terms have changed, and these are conditional rather than marginal probabilities.

It becomes obvious that any improvement in the accuracy of the reliability computations must

occur as the result of improved accuracy in estimating conditional probabilities of success for individual steps. The same conclusion holds for parallel operations in equation (13) except in this instance the improvement will be obtained by estimating the conditional probabilities of failure for task steps.

A major problem arises when one attempts to estimate values for terms in the dependent models. Data stores are available (4) for use in estimating values for terms in the probability models for independent events, but not for dependent events. Yet, one finds, when analyzing human performance reliability, that the great majority of operational procedures encountered are dependent. Unfortunately, data and techniques are not presently available for doing the job.

The problem of estimating values for elements of dependent probability models can be solved only by providing the data and/or techniques needed for taking the dependent relationships into account. In deriving the necessary data and techniques, however, one must consider the anticipated characteristics of future data stores, identification of factors responsible for the dependent relationship, and magnitude of the effect upon probability of successful performance of given steps in an operational task.

Characteristics of Future Data Stores

A probability data store is a tabulation of values representing the probability of successful performance of a defined task or task element by an operator of specified characteristics. Although presently available data stores are limited in the categories of tasks and task elements, environmental conditions, and defined operator characteristics covered, it is not unreasonable to expect that future data stores will cover an extensive range of such categories. It is also possible that the data store will provide distributions of probability values as well as the average or expected values. However, to be economically feasible, the data store must be applicable to a wide range of operations. Probability values listed in the data store must be relevant to common elements of a great variety of systems. The common elements are the individual steps or operations in a task. In the data store developed by the American Institute for Research (4), for example, the common elements are inputs to the operator, mediating processes, and outputs from the operator for specified tasks steps. Values in the data store are immediately relevant to terms in the probability model, if task steps or elements are independent. In other words, the values are marginal probabilities. They do not take into account dependent relationships, for to do so would limit the range of tasks to which

the data store is applicable. One must conclude, therefore, that the conditional probabilities of a model composed of dependent events will not be found in a data store.

It is evident that a serious problem confronts the analyst attempting to estimate the conditional probabilities of dependent models. He must make the estimates prior to the time prototype equipment is available for experimental study. Yet, he has no available source of fully relevant data. The problem can only be solved by development of models for making the transition from the marginal probabilities of the data store to the conditional probabilities of the dependent model.

Form of the Transition Model

Although much preparatory work remains to be done before actual transition models can be constructed, one can determine the general form of the models by using the techniques of experimental design and analysis (5). The conditions relevant to a given step in an operating procedure may be considered as independent variables of a linear model. For the purposes of this analysis, the given step will be referred to as the reference step, and it is the step for which a probability value is being sought. The response of interest or output from the linear transition model is the conditional probability value. One can arrange the conditions or independent variables in an n-dimensional matrix, so that the independent variables giving the response represented by the pertinent marginal probability in the data store are all included in cell 1 of the matrix. Other cells in the matrix represent independent variables forming the basis for the dependency relationships with earlier steps.

To illustrate the approach, assume that the only factors affecting the probability of success in the reference step are equipment design features, type of activity performed, and the presence or absence of a time constraint on the task. Table 1 gives the number of levels and combinations of the independent variables. Terms are defined in the text following the table.

The cell in the upper left-hand corner of Table 1 is designated as cell P_{11}. It gives the probability of successful performance of step j, the reference step, when the equipment design features and operator activities in the reference step are employed in combination with no time constraint; i.e., A_O, D_O, C_O. With only these conditions present, one can estimate the probability of success in the reference step, P_{11}, by means of a marginal probability value from the data store. Suppose that the conditions represented by the cell P_{24}, i.e., A_1, D_1, C_1, are present. This would indicate that equipment design feature D_1 is operated in an earlier step, that activity A_1 is performed in an earlier step, and that the task is performed

under a time constraint. The effect of A_1, D_1 and C_1 is a change in the probability value from P_{11} to P_{24}. Other cells in the matrix may be interpreted in like manner.

Table 1
Matrix of Independent Variables

		D_0	D_1	D_2
A_0	C_0	P_{11}	P_{12}	P_{1e}
	C_1	P_{21}	P_{22}	P_{23}
A_1	C_0	P_{31}	P_{23}	P_{33}
	C_1	P_{41}	P_{24}	P_{34}
A_2	C_0	P_{51}	P_{25}	P_{35}
	C_1	P_{61}	P_{26}	P_{36}

D_0 = design features of equipment operated in reference step

D_1, D_2 = design features of equipment operated in earlier steps

A_0 = activity performed in reference step

A_1, A_2 = activities performed in earlier step

C_0 = no time constraint

C_1 = time constraint imposed on task

Pik = probability of successful performance of step j, the reference step i = 1, 2, 3
k = 1, 2 ..., 6

The probability model for the conditions listed in Table 1 is similar to the linear model for a factorial design in experimental design and analysis (5); i.e.,

$$P(X_j | X_1, X_2, \ldots. X_{j-1}) =$$

$$\underbrace{+\Delta P_1 Y_1 + \Delta P_2 Y_2}_{\text{Equipment}}$$

$$\underbrace{+\Delta P_3 Y_3 = \Delta P_4 Y_4}_{\text{Activity}}$$

$$\underbrace{+\Delta P_5 Y_5}_{\text{Time Constraint}}$$

$$+\Delta P_6 Y_1 Y_3 + \Delta P_7 Y_1 Y_4 + \Delta P_8 Y_1 Y_5 + \Delta P_9 Y_2 Y_3 + \Delta P_{10} Y_2 Y_4$$

$$+\Delta P_{11} Y_2 Y_5 + \Delta P_{12} Y_3 Y_5 + \Delta P_{13} Y_4 Y_5 + \Delta P_{14} Y_1 Y_3 Y_5 + \Delta P_{15} Y_1 Y_4 Y_5$$

$$+\Delta P_{16} Y_2 Y_3 Y_5 + \Delta P_{17} Y_2 Y_4 Y_5 + \epsilon \tag{14}$$

Note that equation 14 is linear in terms of the ΔP's and is referred to as a linear model for this reason.

Definitions for terms in equation 14 are as follows:

$P(X_j | X_1, X_2, \ldots, X_{j-1})$ = the conditional probability that the reference step is performed correctly, given that the j-1 earlier steps have been performed correctly

Y_1 = 1 if equipment design feature D_1 is present in earlier steps*

Y_1 = 0 if equipment design feature D_1 is absent in earlier steps

Y_2 = 1 if equipment design feature D_2 is present in earlier steps

Y_2 = 0 if equipment design feature D_2 is absent in earlier steps

Y_3 = 1 if operator activity A_1 is present in earlier steps

Y_3 = 0 if operator activity A_1 is absent in earlier steps

Y_4 = 1 if operator activity A_2 is present in earlier steps

Y_4 = 0 if operator activity A_2 is absent in earlier steps

Y_5 = 1 if time constraint C_1 is present in earlier steps

Y_5 = 0 if time constraint C_1 is absent in earlier steps

P_0 = mean probability of success in step j when only conditions A_0, D_0, and C_0 are present

ΔP_1 = mean increase or decrease in $P(X_j \mid X_2 \ldots, X_{j-1})$ when D_1 is present in earlier steps

ΔP_2 = mean increase or decrease in $P(X_j \mid X_1, X_2 \ldots, X_{j-1})$ when D_2 is present in earlier steps

ΔP_3 = mean increase or decrease in $P(X_j \mid X_1, X_2 \ldots, X_{j-1})$ when A_1 is present in earlier steps

ΔP_4 = mean increase or decrease in $P(X_j \mid X_1, X_2 \ldots, X_{j-1})$ when A_2 is present in earlier steps

ΔP_5 = mean increase or decrease in $P(X_j \mid X_1, X_2 \ldots, X_{j-1})$ when C_1 is present in earlier steps

ΔP_6 = mean increase or decrease in $P(X_j \mid X_1, X_2 \ldots, X_{j-1})$ due to the interaction between D_1 and A_1

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*Note: Values of 1 or 0 assigned to the Y_j's in the linear model refer to the presence or absence of a variable and not to success or failure in performance of step j.

ΔP_{13} = mean increase or decrease in $P(X_j \mid X_1, X_2 \ldots, X_{j-1})$ due to the interaction between A_2 and C_1

ΔP_{14} = mean increase or decrease in $P(X_j \mid X_1, X_2, \ldots, X_{j-1})$ due to interaction among D_1, A_1, and C_1

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ΔP_{17} = mean increase or decrease in $P(X_j \mid X_1, X_2, \ldots, X_{j-1})$ due to the interaction among D_2, A_2, and C_1

ϵ = error in estimating $P(X_j \mid X_1, X_2, \ldots, X_{j-1})$.

The term P_0 in equation 14 was defined to be the mean probability of success when only the conditions in cell 1 of the matrix are present. By definition, these are the conditions to which the probabilities in the data store apply. Therefore, P_0 may be estimated by means of the appropriate probability value from the data store.

Other parameters in equation 14 represent effects of conditions present in earlier steps in the operational task. Since these conditions are not covered by the data store, one must be concerned with the means for obtaining estimates of their values. Again, one must turn to the methods of experimental design and analysis for an answer. The conditions in table 1 are arranged in a factorial design. Equation 14 is a linear model for this design. Therefore, parameters in the model may be estimated from the results of a properly designed experiment. Note, however, that the response or dependent variable in the present instance is a probability value. One estimates probabilities by means of frequency of success values observed in operational situations or in experimental studies. To obtain frequency of success values, one must conduct not one, but a series of observations or experiments.

Only a small number of the pertinent variables is included in equation 14. Inclusion of a larger number or of all the pertinent variables obviously would greatly increase the number of terms in the model. In a conventional experiment a minimum of one observation must be taken for each parameter in the model. If the number of parameters is large, the work required in conducting a conventional experiment could be excessive. If a series of observations must be taken for each parameter, the work involved will increase accordingly.

Only qualitative variables were included in the example used in developing the linear model (equation 14). When quantitative variables are also included, the model can be constructed to take nonlinear effects into account. For example, if one wished to

investigate the effect of several levels of temperature, terms in the model for main effects would take the form,

$$\Delta P_j Y_j + \Delta P_{j+1} Y^2 + \Delta P_{j+2} Y_j^3 + \ldots\ldots \quad (15)$$

In equation 15, the variable Y_j takes on the pertinent values of temperature. The parameter ΔP_j represents the average linear effect of temperature; ΔP_{j+1} and ΔP_{j+2} represent the average quadratic and cubic effects, respectively, of temperature.

Discussion

Two major problems require solution before significant progress can occur in measurement and prediction of human performance reliability: (1) the factors responsible for dependent relationships among steps in a task must be fully identified, and (2) the effects of the dependent relationships (i.e., the ΔP's in the linear model) must be determined. Obviously, the problem of identifying the factors responsible for the dependent relationships must be solved first. Factors cannot be included in the transition model if they are unknown. Equally important is the need to eliminate factors not having a measurable effect, so that the number of terms in the transition can be reduced to manageable proportions.

Success or failure in the development of transition models ultimately may hinge upon the number of interaction effects occurring in the transition model. In the absence of any interaction among factors, it is possible to isolate factors and determine their effects individually. To determine interaction effects, however, one must study factors in combination with one another. As equation 14 demonstrates, a very small number of factors can generate a large number of interactions. However, if one is willing to neglect the higher order interaction terms, the ΔP's may be determined for the main effects and lower order interaction effects by conducting a series of experiments where only a small number of variables are examined in any one experiment.

CONCLUSIONS

Measurement and prediction of human performance reliability is essential to the design, development and utilization of weapon system. The dependent relationship among steps in a task, however, pose a serious problem. Transition models must be developed to handle the problem and to provide the necessary tools for assessing performance reliability. To accomplish this task the factors responsible for the dependent relationships must be fully identified and values for parameters in the transition model must be established. Interaction effects among the factors responsible for the dependent relationships greatly complicate the transition model. Success or failure in development of the model ultimately may depend upon how numerous the interaction effects prove to be.

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6D. INTEGRATION AND APPLICATION OF COMBAT RELEVANT TASKS, RELIABILITY AND EFFECTIVENESS CRITERIA TO SYSTEM DESIGN

John R. Erickson
U.S. Army Human Engineering Laboratories
Aberdeen Proving Ground, Maryland 21005

In order to discuss the integration and application of combat relevant tasks, reliability and effectiveness criteria to system design, we first have to define our terms and indicate available sources of this information. We can then discuss approaches to integrating and applying this information to system design.

I choose to define combat relevant tasks as all tasks necessary to service, man, and operate a system in the field. Combat relevant tasks can be divided into two groups: (1) Tasks which can be performed more effectively by equipment; and (2) Tasks which can be performed more effectively by man. These tasks can be further subdivided into primary operational tasks which are performed each and every time the system is used, and tasks which are performed periodically and/or intermittently, such as periodic maintenance, fault detection, fault isolation, repair, and calibration.

The terms 'reliability' and 'effectiveness' are concerned with the reliability of the man and his effectiveness in performing a task correctly at the appropriate time, his ability to repeat or maintain his performance over many trials, his ability to maintain his performance in a dynamically changing environment, and his ability to interact with both the equipment and other personnel.

Effectiveness criteria is also concerned with the appropriate balance of operator capabilities, equipment capabilities, and cost to meet system design requirements.

Approaches to identifying combat relevant tasks include a detailed study of:

1. The proposed system description and supporting documents such as Combat Developments Command study reports, Qualitative Materiel Objectives and/or Requirements, the Technical Data Package, the Request for Proposal, etc.

2. Department of Army Field Manuals and Technical Manuals which describe the deployment and operation of current fielded systems that are similar and/or related to the proposed system.

3. Operational tests performed as part of engineer design and engineer/service test during development of similar and/or related systems; and,

4. Utilization of the experience of military personnel who have had recent experience in the field with similar systems.

Once these tasks have been identified, reliability and effectiveness data can be obtained from:

Published literature
Mockup studies
Dynamic simulation
Field studies; and,
Laboratory studies

If we were to look at typical complex military systems currently being developed by the Army we would find certain commonalities. These would include:

1. High mobility requirement -- that is, a capability to move into, set up, engage, tear down, and deploy from position rapidly.

2. Flexibility--that is, a capability to expand or contract as the tactical situation dictates and also to absorb loss of some portions of the system without complete loss of combat effectiveness.

3. A secure communication system which can handle large quantities of data rapidly, facilitate command and control of sub-elements, and communicate with higher echelons as well as adjacent units.

4. High availability requirement--that the system will respond rapidly upon request and continue to operate for the duration of the mission.

5. Be simple to operate and maintain.

6. And last, it will have a minimum manpower requirement for operating and maintaining the system, and that the training requirements and skill level of these personnel be held to a minimum.

Now if we take just these six areas and expand them slightly, you should be able to see the beginnings of the criteria which can be developed for a specific system.

MOBILITY

To me mobility immediately brings to mind a jeep, truck, track-laying vehicles, ground effects machines, or airplanes. It also implies shelter-housed equipment, launchers, guns, and maintenance vans. Operator tasks associated with high mobility include:

Navigation
Vehicle control

Inter- and intra-vehicle communication

On- and off-loading system elements

Equipment set-up and tear-down procedures

Gun laying

Antenna emplacement

Cable laying

Missile assembly/dis-assembly

Electronic equioment check-out and alignment; and,

Vehicle and equipment on-site maintenance

Environment includes:

Lighting-- to include blackout lighting and some special lighting applications

Noise-- to include vehicle engine and road noise, power generating equipment noise, ventilating system noise, weapon noise, etc.

Toxic elements-- engine exhaust, smoke, and fumes from firing weapons, dust, CBR, etc.

Shock and vibration-- due primarily to vehicle motion

Temperature, humidity, air motion

Confined personnel spaces

When it comes to detailing environmental criteria I feel we are generally in fairly good shape, with the exception of shock and vibration. This particular environmental condition has been rather difficult to pin down in terms of criteria when details are discussed (e.g., allowable vibration at a telescope eyepiece, allowable vibration on a man and/or the instrument when performing a reading or fine positioning task, and in general, measures of performance degradation due to various levels of vibration for a multitude of tasks).

A cursory examination of the tasks I just mentioned indicates that some of the tasks are not overly dependent on the type of vehicle, whereas others are. For instance, tasks required to assemble a missile or lay cable between system elements are not overly dependent on the vehicle, although on-loading and off-loading tasks are. On the other hand, vehicle control is definitely dependent on the specific vehicle control dynamics.

Therefore, when it comes to establishing criteria for that area of system design affected by mobility considerations and constraints, some criteria can be readily extracted from the literature, or taken from other system areas; however, other criteria will only be valid if they are based on a good understanding of the system description and the system design approach. In some cases, it may not be possible to develop detail criteria until simulation and trade-off studies as well as preliminary design has established sufficient detail to permit a reasonable selection of appropriate criteria.

FLEXIBILITY

When flexibility is a system requirement it will have to be taken into account in developing criteria. Work station layout criteria may have to address adding or removing system elements. Under one set of operating conditions a shelter may contain one attendant and switchboard, but under another condition two attendants will be required. Another example would be where a control panel mounted on a missile launcher is used while the operator stands on the ground but the launcher itself can either be vehicle-mounted or emplaced on the ground. One set of controls and/or grouping of controls and displays may be used when all system elements are performing satisfactorily, but a somewhat different set or grouping of controls and displays would be used when the system degrades. When requirements of this nature are foreseen, criteria should be developed to guide the designer to optimize the design for the operator and maintenance technician. It is also conceivable that because of flexibility requirements, the capabilities of the user may tend to be overlooked or a tendency to dump hard to resolve design problems onto the operator may evolve. This can happen in a subtle way and may require some mockup effort or simulation to achieve a reasonable trade-off. Another facet of this problem is the effect of workload on the operator when the system degrades. If this is not considered, the equipment may have the capability to handle system degradation but operator reliability may fall off so fast that the system in effect fails.

COMMUNICATIONS

Communicstions can obviously be a major system itself, such as the Army Area Communications System and the Random Access Discrete Address System, or it can be a major subsystem of other systems such as an air defense or command-control system, etc. A communication system can be restricted to voice or include digital data, facsimile, teletypewriter data, etc. Regardless of complexity, certain basic requirements have to be met and accounted for; these include communication environment, specific tasks required to operate and maintain the communication equipment, and integrating the communication equipment with other system elements.

Previously mentioned environmental considerations apply to communication facilities, although they may be more restrictive than for other applications. For instance, a more stringent noise criteria is required to assure adequate voice communication than is necessary for loading projectiles in a gun. On the other hand, the same temperature environmental criteria appears appropriate for a radio-teletypewriter operator as for a missile fire-control or radar operator, since all these tasks require finger dexterity and relatively long sedentary watches.

Specific tasks should be detailed as soon as practical and estimates of task completion times and number of personnel required to per' rm the tasks should be made to assure that system reaction times can be met within prescribed personnel limitations.

In addition, workspace layout and panel and console layouts should be blocked out to facilitate a proper integration of communication equipment with other system elements to assure an effective arrangement of personnel and equipment.

AVAILABILITY

This generally encompasses reliability and maintainability, or in terms of components, the mean-time-before-failure and the mean-time-to-repair. Since human factors personnel are not primarily concerned with component reliability per se, I think of availability in terms of personnel reliability, and mean-time-to-repair. That is, the components that comprise a missile or communication system may be capable of performing properly; however, the system will not be operationally available until it has been emplaced properly, aligned correctly, the sub-elements interconnected, and the system calibrated and checked-out properly. In a very real sense, a system's availability is dependent upon the reliability of the operating and maintenance personnel in performing their tasks correctly and expeditiously. To assist operating and maintenance personnel in meeting availability requirements, criteria should reflect ease of access to critical components, clear and concise labeling, straight-forward operating and maintenance procedures, as well as a logical, simple means of sensing system malfunctions, isolating the defective element, and effecting corrective action.

SIMPLICITY OF OPERATION AND MAINTENANCE

I believe that the requirement for designing to achieve simplicity of operation and maintenance should be self-evident. To bring this requirement into focus, I would like to remind you that the majority of soldiers are in their late teens or early twenties, have been drafted for two years, are in the Army primarily to engage the enemy and defeat him in combat, and are not in the Army to be trained as technicians. The ultimate toward achieving simplicity of operation and maintenance probably is the go-no-go indicator, the wooden round concept and the throw-away module. Obviously this is not achievable all the time; however, it can be approached by developing human factors criteria for a specific system that identifies those task elements that an average soldier can perform adequately with a minimum of training and experience, and relegates those tasks which are cumbersome for the soldier to perform to the equipment.

MANPOWER

This is the most expensive and critical component of any operational system. It is also probably the most difficult component to quantify and also the most variable. However, it must be described and quantified early in the design process to allow time to obtain and train the required personnel so they will be available when the hardware is available for issue. Therefore, in order to meet this requirement a preliminary task and skill analysis should be conducted during concept definition in order to block-out manpower requirements. As system design becomes more firm, recommended operating and maintenance procedures and maintenance allocation charts should be prepared. These analyses and charts will assist in describing design features which require special emphasis in training, identify peculiar skill requirements and aid in approaching logical operating and maintenance procedures which will most effectively utilize system personnel.

The purpose for performing the preceding detailed analysis of the proposed system in terms of combat relevant tasks, human factors reliability and effectiveness is two-fold:

First, from this analysis the human factors specialist can identify areas which may be considered in future trade-off analyses and identify penalties that would be incurred in total system performance effectiveness if human performance is indiscriminately traded off against equipment design or cost.

Second, from this analysis the human factors specialist can define that work which should be performed by the contractor's human factors group during system development as well as the criteria against which his performance can be measured.

In summary, I have attempted to describe several operational requirements common to most complex systems which can be used for identifying specific areas which should be investigated during concept definition and from which a human factors criteria should evolve. I have also indicated, in general terms, sources from which a considerable amount of data can be extracted for inclusion in the human factors criteria. And finally, it should be recognized that a sound human factors effort during concept definition can contribute to realistic cost effective trade-off studies, as well as establishing the basis for a continuing program to identify and solve human factors problems during system development.

APPENDICES

APPENDIX 1

ATTENDANCE ROSTER

Mr. Vincent A. Abbatiello
Instructor
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

Dr. Preston S. Abbott
Director, Center for Research in Social Systems
Washington, D. C. 20016

Mr. Jeff Abraham
Engineering Psychologist
USAEPG
Fort Huachuca, Arizona 85613

Major David G. Adams
CD Staff Officer
Institute for Land Combat
Fort Belvoir, Virginia 22060

Colonel A. J. Affleck
Director of Psychology
Australian Army Headquarters
Canberra, A. C. T., Australia

Mr. Max H. Alexander
Mechanical Engineer
US Army Tank Automotive Command
Warren, Michigan 48030

Mr. Charles J. Anderson
Technical Director, Project COBET
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

Major Charles W. Andy
Communications-Electronics, USACDC
Fort Gordon, Georgia 30905

Dr. Lynn E. Baker
US Army Chief Psychologist
US Army Research Office, OCRD, DA
Washington, D. C. 20310

LTC Ferdinand O. Barger, Jr.
Chief, US Army Infantry Human Research Unit
Fort Benning, Georgia 31905

Colonel M. O. Becker
CO, US Army Behavioral Science Research Laboratory
Washington, D. C. 20315

Major Alexander D. Bell
Chief, US Army Air Defense Human Research Unit
Fort Bliss, Texas 79916

Mr. Herbert S. Bennett
Electronics Engineer
US Army Electronics Command
Fort Monmouth, New Jersey 07703

Dr. Rudolph G. Berkhouse
Research Psychologist
Behavioral Sciences Division
US Army Research Office, OCRD, DA
Washington, D. C. 20310

LTG Austin W. Betts
Chief of Research and Development
Department of the Army
Washington, D. C. 20310

Mr. Werner W. Beyth
Physical Scientist
US Army Munitions Command
Dover, New Jersey 07801

Mr. Richard P. Blake
Deputy Chief, Office of the Canadian Defense Research Staff
Washington, D. C. 20310

Mr. Harold S. Block
General Engineer
ACSI, DA
Washington, D. C. 20310

Mr. Joel N. Bloom
Technical Director
Franklin Institute Research Labs
Philadelphia, Pennsylvania 19103

Mr. Robert O. Border
Mechanical Engineer
Rock Island Arsenal
Rock Island, Illinois 61201

Dr. Olin H. Borum
Physical Science Administrator
US Army Materiel Command
Washington, D. C. 20315

Mr. Andrew J. Britten, Jr.
Physicist, US Army
Frankford Arsenal
Philadelphia, Pennsylvania 19137

Colonel George Brooks
Director, Office of Logistics
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

Major Roger J. Browne II
Operations Evaluator
USACDC Institute of Nuclear Studies
Fort Bliss, Texas 79916

Colonel E. D. Bryson
Chief, PRD, DCSPER, DA
Washington, D. C. 20310

Dr. Bruce L. Bucklin
Psychologist
Picatinny Arsenal
Dover, New Jersey 07801

Major Peter C. Bunevich
Studies Analysis Division, Army Research Office, OCRD, DA
Washington, D. C. 20310

Dr. George G. Burgess
Research Psychologist
DCSPER, DA
Washington, D. C. 20310

Mr. Richard L. Burse
Research Anthropologist
US Army Natick Laboratories
Natick, Massachusetts 01760

Dr. Ruth Hoyt-Cameron
Defense Research Board
Ottawa 4, Ontario, Canada

Colonel Charles J. Canella
Chief, Behavioral Sciences Division
Army Research Office, OCRD, DA
Washington, D. C. 20310

Mr. Jack Carlock
Psychologist
Picatinny Arsenal
Dover, New Jersey 07801

Colonel Irvin F. Carpenter
Chief, US Army Strategy and Tactics Analysis Group
Bethesda, Maryland 20014

Mr. William K. Carr
Research Scientist, Center for Research in Social Systems
Washington, D. C. 20016

Colonel George T. Casey
Director, Plans, Programs and Policies
Office of Chaplains, DA
Washington, D. C. 20315

Colonel Duane S. Cason
Chief, Plans and Programs Office, OPO, DCSPER, DA
Washington, D. C. 20310

Mr. Gerald Chaikin
Engineer
US Army Missile Command
Redstone Arsenal, Alabama 35809

Mr. Robert F. Chaillet
Chief, TSO, US Army Human Engineering Laboratories
Aberdeen Proving Ground, Maryland 21001

LTC Eugene F. Chandler
Chief, Human Factors Division
USACDC, Communications-Electronics
Fort Ord, California 93941

Mr. Thomas E. Chandler
Chief, Evaluations Division
US Army Southeastern Signal School
Fort Gordon, Georgia 30905

LTC Charles N. Childers
Training and Operations Staff Officer
US Continental Army Command
Fort Monroe, Virginia 23363

Mr. John Chipser
Engineer
US Army Missile Command
Redstone Arsenal, Alabama 35809

Colonel Gervaise S. Chittick
Military Analyst
US Army Combat Development Command
Fort Lee, Virginia 23801

Dr. Vincent P. Cieri
Technical Director, Project CAI
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

Mr. William F. Clark
Mechanical Engineer
US Army Mobility Equipment R&D Center
Fort Belvoir, Virginia 22060

Colonel Carter W. Clarke, Jr.
Chief, PSYOP Division
DCSOPS, DA
Washington, D. C. 20310

Colonel Roy E. Clausen, Jr.
Director, Personnel and Training
Office of the Surgeon General, DA
Washington, D. C. 20315

LTC John H. Claybrook
Chief, Field Experiment-Troop Test Branch, USACDC, Combat Support Group
Fort Belvoir, Virginia 22060

Mr. Warren F. Clement
Senior Staff Engineer
Systems Technology, Inc.
Princeton, New Jersey 08540

CPT Jerome A. Collins
US Army Medical Research and Development Command, DA
Washington, D. C. 20315

LTC Gordon C. Conklin
Behavioral Sciences Division
Army Research Office, OCRD, DA
Washington, D. C. 20310

Colonel David Cooper
Deputy Director, DR and TL
US Army Air Defense School
Fort Bliss, Texas 79916

Mr. Douglas Y. Cornog
Chief, Human Factors Branch
US Post Office Department
Washington, D. C. 20206

LTC Joseph M. Corvino
Member, Institute of Advanced Studies, USACDC
Carlisle Barracks, Pennsylvania 17013

LTC Edward B. Covington III
Chief
US Army Aviation Human Research Unit
Fort Rucker, Alabama 36360

Colonel Charles L. Crain
Chief, Classification and Standards Division, DCSPER, DA
Washington, D. C. 20310

Dr. Meredith P. Crawford
Director, Human Resources Research Office, George Washington University
Alexandria, Virginia 22314

LTC Steven S. Crowell
Assistant Chief of Staff for Force Development, DA
Washington, D. C. 20310

LTC James F. Culp
Behavioral Sciences Division
Army Research Office, OCRD, DA
Washington, D. C. 20310

Dr. Arnold E. Dahlke
Associate Director for Research and Planning, CRESS, American University
Washington, D. C. 20016

Major Otis D. Daniels
Department of Nonresident Instruction
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

Colonel Warren P. Davis
Chief, Personnel Management Development Office, DCSPER, DA
Washington, D. C. 20315

Mr. Vaughn E. Davison
Senior Educational Advisor
US Army Missile and Munitions Center and School
Redstone Arsenal, Alabama 35809

1LT Walter T. Decker
Training Officer
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

Mr. William J. Doherty
Human Factors Engineer
Defense Communications Agency, DCEO
Washington, D. C. 20305

LTC James D. Donnelly
Behavioral Sciences Division
Army Research Office, OCRD, DA
Washington, D. C. 20310

Dr. Arthur J. Drucker
Assistant Director of Operations
US Army Behavioral Science Research Laboratory
Washington, D. C. 20315

1LT William C. Dunham
Aide-de-Camp, Commanding General
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

Dr. Edwin R. Dusek
Director, Behavioral Sciences Laboratories
Natick, Massachusetts 01760

Dr. Claude B. Elam
Director of Human Factors
Bell Helicopter Company
Fort Worth, Texas 76101

Colonel John E. Ely
Automatic Data Field Systems Command
Chief, TOS Division
Fort Belvoir, Virginia 22060

Mr. Jerry A. Emery
Supervisor, Human Factors
Philco-Ford Corporation
Newport Beach, California 92663

Mr. John R. Erickson
Chief, Missile Communications/GS Branch, US Army Human Engineering Laboratories
Aberdeen Proving Ground, Maryland 21001

Dr. Selby Henry Evans, Jr.
Associate Professor of Psychology
Texas Christian University
Fort Worth, Texas 76101

Lieutenant Ivan N. Evonic
Research Officer, Canadian Forces
Personnel Applied Research Unit
Toronto 12, Ontario, Canada

Mr. Yewell M. Farmer
Chief, Doctrine Branch
O & D Division, ACSI, DA
Washington, D. C. 20310

Major Henry S. Fix, Jr.
Management Analyst
Office of the Adjutant General, DA
Washington, D. C. 20310

1LT Brian E. Forst
Operations Research Projects Officer
Office of Personnel Operations, DA
Washington, D. C. 20310

Dr. Joseph Frank
Chief, Instructional Methods Division
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

Mr. Richard E. Franseen
Project Engineer
US Army R & D Laboratories
Fort Belvoir, Virginia 22060

Mr. Quentin Frazier
Atmospheric Sciences Laboratory
US Army Electronics Command
Fort Monmouth, New Jersey 07703

LCDR Thomas J. Gallagher
Human Factors in Military Systems
Bureau of Medicine and Surgery
Washington, D. C. 20390

Mr. Hannibal Geruntho
Mechanical Engineer
US Army Electronics Command
Fort Monmouth, New Jersey 07703

Mr. Seymour L. Goldberg
Operations Analyst
US Army CDC
Fort Belvoir, Virginia 22060

Mr. Sidney Goldstein
Physicist
Frankford Arsenal
Philadelphia, Pennsylvania 19137

2LT Donald R. Gomez
Deputy Chief, Support Branch
USAIIC
Fort Holabird, Maryland 21219

Colonel Andrew G. Gorski
DCSPER-DIT, Rm 2C741
Department of the Army
Washington, D. C. 20310

Mr. Charles O. Gray
Educational Advisor
US Army Ordnance Center and School
Aberdeen Proving Ground, Maryland 21001

Colonel James S. Greene, Jr.
Chief, TSD Branch, DCSPER
US Continental Army Command
Fort Monroe, Virginia 23351

Mr. Paul E. Griffith
Chief, Applications Engineering Branch
US Army Electronics Command
Fort Monmouth, New Jersey 07703

LTC Gus H. Grisard
Secretary
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

LTC Marvin Grunzke
HQ US Air Force, AFPDT
Tempo 8 # 2315
Washington, D. C. 20333

Mr. Harry I. Hadley
Technical Director
Personnel Management Office, DA
Washington, D. C. 20315

Mr. George M. Hall, Jr.
Education Specialist
US Army Engineer School
Fort Belvoir, Virginia 22150

Mr. Howard S. Halpern
Chief, Advanced Engineering Systems
United Aircraft Corporation
Norwalk, Connecticut 06851

Mr. Douglas H. Harris
Group Scientist
North American Rockwell Corporation
Anaheim, California 92803

Mr. William M. Hartness
Scientific Advisor
USACDC Special Warfare Agency
Fort Bragg, North Carolina 28307

Mr. Andrew S. Hartos
Electronics Engineer
US Army Electronics Command
Fort Monmouth, New Jersey 07703

LTC William Q. Harty
US Army Armor Human Research Unit
Fort Knox, Kentucky 40121

Mr. Maurice J. Healy
P.O. Project Officer, DAC
US Army Special Warfare School
Fort Bragg, North Carolina 28307

LTC James L. Hedlund
Chief, Biomedical Stress Research Branch, Office of the Surgeon General
Washington, D. C. 20315

Mr. Theodore C. Hein
Mathematician
Night Vision Laboratories
Fort Belvoir, Virginia 22060

Dr. John R. Hennessy
Avionics Laboratory
US Army Electronics Command
Fort Monmouth, New Jersey 07703

Mr. Kenneth A. Herbst
Mechanical Engineer
US Army Weapons Command
Rock Island, Illinois 61201

Dr. Charles M. Hersh
Special Assistant to Director of Personnel Studies and Research, DCSPER
Washington, D. C. 20310

Mr. Arthur J. Hoehn
Director of Research
The George Washington University
Alexandria, Virginia 22314

Mr. Wendell R. Holt
Staff Engineer
Fairchild Hiller Corporation
Germantown, Maryland 20767

Colonel Willard V. Horne
Director, Department of Command Communications
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

Mr. Edward F. Howard
Psychologist (Engineer)
US Navy Underwater Sound Laboratory
New London, Connecticut 06340

CPT Frederick Isgrig
US Army Natick Laboratories
Natick, Massachusetts 01760

Mr. Samuel E. Jackson
Research Psychologist
Human Factors Branch, MRL
Edgewood Arsenal, Maryland 21010

Mr. Harry L. Jacobs
Director for Behavioral Sciences
US Army Natick Laboratories
Wayland, Massachusetts 01178

CPT Robert L. Janoska
Project Officer, P&TL Division
US Army Armor School
Fort Knox, Kentucky 40121

Mr. Thomas E. Jeffrey
Senior Project Director
US Army Behavioral Science Research Laboratory
Washington, D. C. 20315

LTC Albert C. Johnson
Deputy Director, DST
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

Mr. Cecil D. Johnson
Chief, Statistical Research and
Analysis Division
US Army Behavioral Science
Research Laboratory
Washington, D. C. 20315

Dr. Lawrence B. Johnson
Senior Scientist
Raff Analytic Study Associates,
Inc.
Silver Spring, Maryland 20910

Mr. Leonard E. Johnson
Supervisory Education Specialist
HQ, USATSCH
Fort Eustis, Virginia 23604

Mr. William A. Johnson
AMSWE-RDW
Rock Island Arsenal
Rock Island, Illinois 61201

Dr. Daniel B. Jones
Missile and Space Systems
Division, McDonnell Douglas
Corporation
Santa Monica, California 90406

Mrs. Emily J. Jones
Psychology Technician
US Army Human Engineering
Laboratories
Aberdeen Proving Ground,
Maryland 21001

LTC Albert E. Joy
Chief, Research Programs Office
Army Research Office, OCRD, DA
Washington, D. C. 20310

Mr. Richard P. Joyce
Analyst
Research Analysis Corporation
McLean, Virginia 22101

Mr. Harold Kanter
Education Advisor, DCC
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

Mrs. Carmel Louise Kasper
Scientific Officer
Directorate of Land Operational
Research of the Canadian Forces
Headquarters
Ottawa, Ontario, Canada

Mr. Richard H. Kause
Psychologist
Goodyear Aerospace Corporation
Akron, Ohio 44315

Mr. James R. Kennedy
Engineering Technician
Production and Maintenance
Division
Fort Detrick, Maryland 21701

CPT Harold O. Kiess
Experimental Psychologist
US Army Natick Laboratories
Natick, Massachusetts 01760

LTC Howard W. Killam
Assistant Chief for Engineering
Support, DCA, DCEO
Washington, D. C. 20305

Dr. Fritz E. Klaiber
Electronics Engineer
US Army Electronics Command
Fort Monmouth, New Jersey 07703

LTC Richard P. Koch
USACDC / Personnel and Administrative Services Agency
Fort Benjamin Harrison, Ind 46249

Colonel Francis E. Kramer
Deputy Assistant CS&FB
US Army Artillery and Missile School
Fort Sill, Oklahoma 73503

Mr. J. Fred Kreissig
Chief, Production and Maintenance Division
Fort Detrick, Maryland 21701

Mr. Richard L. Krumm
Executive Staff Scientist
Bunker-Ramo Corporation
McLean, Virginia 22101

Dr. Martin I. Kurke
Senior Staff Analyst
Technical Operations, Incorporated
Alexandria, Virginia 22304

Mr. Daniel Landis
Senior Research Psychologist
Systems Science Department
Franklin Institute Research Lab
Philadelphia, Pennsylvania 19103

MG William B. Latta
Commanding General
US Army Electronics Command &
Fort Monmouth, New Jersey 07703

Major Murray W. Lennox
Canadian Liaison Officer
US Army Electronics Command
Fort Monmouth, New Jersey 07703

Dr. Girard W. Levy
Staff Scientist
North American Rockwell, Inc.
Columbus, Ohio 43216

Mr. Joseph A. Levy
Physicist
US Army Electronics Command
Fort Monmouth, New Jersey 07703

Mr. H. Greig Lindner
Staff Engineering Psychologist
McDownell Astronautics Company
Titusville, Florida 32780

Major Ramon R. Lopez
Education Psychologist
DCSPER, DA
Washington, D. C. 20310

LTC Walter C. Lowry, Jr.
Chief, RT Division
ACSFOR, DA
Washington, D. C. 20310

Mr. Joseph Mangiaracina
Education Advisor, DST
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

LTC Donald S. Marshall
General Staff, Directorate of Personnel Studies and Research
Washington, D. C. 20310

Mr. Earl W. Martin
Member Technical Staff
USACDC Infantry Agency
Fort Benning, Georgia 31905

Dr. William A. McClelland
Associate Director, HUMRRO
George Washington University
Alexandria, Virginia 22314

Dr. John W. McCrary
Senior Scientist, HUMRRO
George Washington University
Alexandria, Virginia 22314

Dr. John M. McGinnis
Research Psychologist
US Army Natick Laboratories
Natick, Massachusetts 01760

Mr. Eugene J. McGuigan
Chief, Human Factors Branch
US Army Frankford Arsenal
Philadelphia, Pennsylvania 19137

Colonel W. J. McIntyre, Jr.
Deputy Commandant
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

Colonel John A. Meads, Jr.
US Continental Army Command
Fort Monroe, Virginia 23351

LTC Joseph O. Meerbott
Executive Officer
US Army LD & SA
New Cumberland Army Depot
Harrisburg, Pennsylvania 17105

LTC Bernard F. Mewhort
Deputy Chief, ACSC-E, DA
Washington, D. C. 20310

Colonel Chester L. Myers
Commanding Officer, School Brigade
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

Major James R. Miller
DCSPER(DP), DA
Washington, D. C. 20310

Major William R. Miner
Chief, Plans Branch, P&PD
US Army Infantry School
Fort Benning, Georgia 31905

LTC Charles B. Modisett
Deputy Chief, Signal Branch
OPD, OPEROPS, DA
Washington, D. C. 20315

Colonel Albert R. Moss
Director, Chaplain Agency
USACDC, Chaplain Agency
Fort Lee, Virginia 23801

Colonel Loran E. Mott
Deputy Commanding Officer
USACDC Medical Service
Fort Sam Houston, Texas 78234

Dr. John V. Murphy
Member, Senior Technical Staff
Litton Systems
Woodland Hills, California 91364

Mr. Henry Naylor
Assistant Program Manager
MBT 70 Study
General Precision Systems
Oper Tng Div Link Group
Silver Spring, Maryland 20901

BG Charles D. Y. Ostrom, Jr.
Director of Army Research
Army Research Office, OCRD, DA
Washington, D. C. 20310

Mr. John L. Owen
Chief, P & R Division, DNI
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

Mr. Louis Paul
Electronics Engineer
US Army Electronics Command
Fort Monmouth, New Jersey 07703

Mr. Hugh M. Pease
Classification & Wage Specialist
DCSPER, DA
Washington, D. C. 20310

Dr. J. C. Penton
Assistant Director for Operational Research, Human Factors
United Kingdom Ministry of Defense
Whitehall London, S. W. I., England

Mr. Kenneth A. Perko
Project Manager
Goodyear Aerospace Corporation
Akron, Ohio 44315

Colonel Robert L. Perley
Director of Instruction
US Army Southeastern Signal School
Fort Gordon, Georgia 30905

Mr. Arnold C. Peterson
Electronics Engineer
US Army Electronics Command
Fort Monmouth, New Jersey 07703

Mr. Luigi Petrullo
Director, Psychological Sciences Division, Office of Naval Research
Washington, D. C. 20360

Major John J. Peyton
Public Information Officer
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

CPT Russell M. Phelps
Research and Development Coordinator
US Army Human Engineering Laboratory
Aberdeen Proving Ground, Maryland 21001

Mr. Charles T. Pierce
Electronic Engineer
US Army Electronics Command
Fort Monmouth, New Jersey 07703

Dr. Arthur C. Poe, Jr.
Senior Education Advisor
US Army Aviation School
Fort Rucker, Alabama 36360

BG Carleton Preer, Jr.
Director, Directorate for ROTC/NDCC
US Continental Army Command
Fort Monroe, Virginia 23351

Mr. Aloysius K. Quinn
Senior Education Advisor
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

LTC Thomas A. Rehm
Assistant Professor of Military Psychology and Leadership
US Military Academy
West Point, New York 10996

BG Thomas Matthew Rienzi
Commanding General
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

Mr. Seymour Ringel
Senior Task Leader
US Army Behavioral Sciences Research Laboratory
Washington, D. C. 20315

Mr. Raymond Robbiani
Electronic Engineer
US Army Electronics Command
Fort Monmouth, New Jersey 07703

Mr. Stanley H. Robertson
Human Factors Engineering
USAMERDC
Fort Belvoir, Virginia 22060

Dr. Robert T. Root
Staff Psychologist
HRB-Singer, Incorporated
State College, Pennsylvania 16801

Dr. George E. Rowland
President
Rowland & Company, Incorporated
Haddonfield, New Jersey 08033

Mr. Will C. Rowland
Intelligence Research Specialist
USACDC, Intelligence Agency
Fort Holabird, Maryland 21219

Mr. Donald S. Rubenstein
Deputy Director of Civilian
Personnel, DCSPER, DA
Washington, D. C. 20310

Mr. Arnold I. Rubinstein
Psychologist
Naval Material Command
Department of the Navy
Washington, D. C. 20360

Colonel Walter G. Runte
Director, Office of Academic
Operations
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

Mr. Mark J. Salsbury
Physicist
Research and Engineering
Division
Rock Island Arsenal
Rock Island, Illinois 61201

Mr. Herman J. Sander
Deputy Chief BES Division
Headquarters, OAR (AFOSR)
Arlington, Virginia 22209

Mr. Anthony S. Santanelli
Research Psychologist
US Army Electronics Command
Fort Monmouth, New Jersey 07703

Mr. Harold A. Schulz
ODCSIT Educational Advisor
US Continental Army Command
Fort Monroe, Virginia 23351

Colonel Theodore F. Schweitzer
Director of Instruction
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

LTC Jozef F. Senna
US Army Standardization Group
United Kingdom, London, England

Mr. Moses Sharenow
Physicist
US Army Electronics Command
Fort Monmouth, New Jersey 07703

Mr. Albert L. Shepherd
Representative at Headquarters
HUMRRO, USCONARC
Alexandria, Virginia 22314

Mr. James L. Sherrill
Educational Advisor
The Army Adjutant General School
Fort Benjamin Harrison, Indiana
46216

Colonel Robert Sherwood
Deputy Chief of Staff for R & D
US Army Security Agency
Arlington Hall Station
Arlington, Virginia 22212

Mr. Joel L. Sidel
Research Psychologist
US Army Natick Laboratories
Natick, Massachusetts 07160

Dr. Arthur Siegel
Director, Applied Psychological
Services
Wayne, Pennsylvania 19087

Dr. Albert H. Smith
DSSO 5
Defense Research Establishment
Toronto, Ontario, Canada

Dr. Charles N. Spinks
Senior Research Scientist
Center for Research in Social Systems
Washington, D. C. 20016

Mr. Matthew J. Stowell
ADP Training Officer
OACSDS, USCONARC
Fort Monroe, Virginia 23351

Commander Charles N. Straney
ASW Programs Officer, US Navy Underwater Sound Laboratory
New London, Connecticut 06320

Colonel Robert W. Strunk
Chief, Logistics, Personnel and Training Group, LDSO, DCSLOG, DA
Washington, D. C. 20310

Mr. Dennis J. Sullivan
Member of Technical Staff
The Bunker-Ramo Corporation
Defense Systems Division
Canoga Park, California 91304

2LT Joseph E. Swistak
Project Engineer/Psychologist
Night Vision Laboratories
Fort Belvoir, Virginia 22060

Mr. Hugh W. Swofford
Scientific Advisor
H. W. Swofford and Company, Inc.
New York, New York 10022

BG Orwin C. Talbott
Assistant Chief of Staff for Individual Training, USCONARC
Fort Monroe, Virginia 23351

LTC J. T. Tambe
Behaviorial Sciences Division
Army Research Office, OCRD, DA
Washington, D. C. 20310

Mr. John D. Taylor
Education Specialist
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

Mr. Murray V. Tesser
Deputy Chief, TV Division, OAO
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

LTC Charles A. Thomas, Jr.
Psychology Consultant
Office of the Surgeon General, DA
Washington, D. C. 20315

Dr. James A. Thomas
Supervisory Research Psychologist
Personnel Studies Division, DCSPER, DA
Arlington, Virginia 22202

Dr. Kenneth F. Thomson
Staff Psychologist
Naval Training Device Center
Orlando, Florida 32813

Mr. William Tomlinson
Electronics Division
General Dynamics Corporation
Rochester, New York 14601

Mr. Frank L. Treadwell
Advanced and Engineering Plans Officer, USAETL
Fort Belvoir, Virginia 22060

LTC N. G. Trower
Canadian Forces, Mobile Command
St. Hubert, P.Q., Canada

Dr. J. E. Uhlaner
Director
US Army Behavioral Research Science Laboratory
Washington, D. C. 20315

Mr. Frank L. Vicino
Engineering Specialist
Litton Scientific Support Laboratory
Fort Ord, California 93941

Colonel Karl W. Volk, Jr.
Executive Assistant to Commanding General, US Continental Army Command
Fort Monroe, Virginia 23351

Rear Admiral Frank B. Voris
Assistant Chief of Research & Military Medical Specialties
Bureau of Medicine and Surgery
Department of the Navy
Washington, D. C. 20390

Dr. Raymond O. Waldkoetter
Supervisory Research Psychologist
US Army Enlisted Evaluation Center
Fort Benjamin Harrison, Indiana 46249

LTC Henry R. Walls, Jr.
US Army Intelligence School
Fort Holabird, Maryland 21219

Colonel Louis A. Waple
Assistant Commandant
US Army Special Warfare School
Fort Bragg, North Carolina 28307

LTC William A. Watson
Chaplain, Office of the Chaplain
US Army Electronics Support Command
Fort Monmouth, New Jersey 07703

Dr. John D. Weisz
Technical Director
US Army Human Engineering Laboratories
Aberdeen Proving Ground, Maryland 21001

Mr. Melvin Werksman
Comptroller
US Army Signal Center and School
Fort Monmouth, New Jersey 07703

Mr. Robert M. White
Research Anthropologist
US Army Natick Laboratories
Natick, Massachusetts 01760

Mr. Eric G. Wibom
Section Head Human Engineering
US Army Electronics Command
Fort Monmouth, New Jersey 07703

LTC Sylvester L. Wihelmi
Research Planning Officer
Army Research Office, OCRD, DA
Arlington, Virginia 22204

Mr. Herman L. Williams
Senior Staff Engineer
Martin-Marietta Corporation
Orlando, Florida 32805

LTC Arthur E. Wolf
US Army Intelligence School
Fort Holabird, Maryland 21219

Mr. Alan W. Wood
Human Factors Engineer
US Army Electronics Command
Fort Monmouth, New Jersey 07703

General James Karrick Woolnough
Commanding General
US Continental Army Command
Fort Monroe, Virginia 23351

Dr. Joseph Zeidner
Chief, Support System Research
Division
US Army Behavioral Science
Research Laboratories
Washington, D. C. 20315

Dr. Hans K. Ziegler
Chief Scientist
US Army Electronics Command
Fort Monmouth, New Jersey 07703

APPENDIX 2

CURRENT WORK PROGRAMS, BIBLIOGRAPHIFS AND BIOGRAPHICAL DIRECTORIES OF PROFESSIONAL PERSONNEL OF HUMAN FACTORS RESEARCH AND DEVELOPMENT ACTIVITIES OF U.S. ARMY AGENCIES

2A. U. S. ARMY BOARD FOR AVIATION ACCIDENT RESEARCH

Fort Rucker, Alabama

INTRODUCTION

Located at Fort Rucker, Alabama, USABAAR was established and organized in 1957 as a Class II activity of the Assistant Chief of Staff for Force Development. Its mission, as defined by AR 15-76, is to conduct research of worldwide aviation accident and related experience to determine where improvements can be made in aviation materiel, operations, supervision, personnel, and training. Based on this research, the Board recommends appropriate action to enhance the durability, reliability, and efficiency of Army aviation, particularly in its combat environment. Unlike most research organizations, USABAAR is not funded by each specific project. Instead, it is given an annual appropriation from Operation and Maintenance, Army funds.

WORK PROGRAM

1. Program includes on-site investigation of Army aircraft accidents and continual review and analysis of accident investigation reports. The purpose of this program is to learn about the human component of accident prevention, since people plus hardware equal accidents. Inherently the accomplishment of this objective encompasses the broad spectrum of human factors indicated by the following areas:

   a. Physiological - physical stress in flight; fatigue; sensory organs, vertigo and illusions; physical fitness, injury causation and prevention, and autopsies.

   b. Psychological - man-machine relationship, experience and knowledge, psychomotor skills and errors, attention and errors of judgment, training and selection.

2. The data gathered in the cited areas are for the primary purpose of enhancing the mission capability of Army aviation. The data are used widely, including the earliest stages of the life cycle of new aircraft, the modification of existing aircraft and as a source of feed-back of training and operational programs. In addition, the data are used in the preparation of reports, presentations, and justification for new specifications and regulations or revisions to existing ones. Some of the specific accomplishments of the past year are:

a. Equipment Evaluation

(1) Flight Clothing
(2) Magnetic Chip Detector Warning Lights
(3) Ballistic Canopy Spreading Device
(4) Escape System
(5) Lightweight VHF in O-1A and OH-13 Aircraft
(6) Analyses of Impact Head Injuries and Helmet Effectiveness
(7) Study of Role of Personal Equipment in Aircraft Fires
(8) Study of Helicopter Accidents Involving Fire
(9) Study of CH-47 Transmission Failures
(10) Crash Resistant Fuel Cells
(11) Spectrometric Oil Analysis
(12) EIR Evaluation
(13) ECP Program
(14) UH-1 Armored Seats
(15) Disorientation Survey

b. Safety Education Media

(1) U. S. Army Aviation Digest
(2) Weekly Summary of Army Aircraft Accidents, Incidents, Forced Landings, Precautionary Landings, and Snare-its
(3) Monthly Maintenance Summary of Army Aircraft Accidents, Incidents, Forced Landings, and Precautionary Landings
(4) National Guard Monthly Summary of Aircraft Accidents, Incidents, Forced Landings, and Precautionary Landings
(5) 1967 Aircraft Accident Prevention Survey
(6) DA Pamphlets
(7) Flight Surgeon Letters
(8) Posters
(9) Crash Plan Guide
(10) Director of Army Aviation Monthly Newsletter
(11) Flight Safety Foundation GASE Bulletin
(12) Engine Accident Summary
(13) Command Aviation Safety Review
(14) Aircraft Accident Summaries
(15) Report of Wire Strike Accidents in Army Aircraft
(16) Fire in U. S. Army Helicopter Accidents

ORGANIZATION

The human factors effort is closely coordinated with the other functions of USABAAR in order to cover the spectrum of human factors as a source of causation in aircraft accidents.

2B. U. S. ARMY MATERIEL COMMAND ELECTRONICS COMMAND

Fort Monmouth, New Jersey

A. Task 1TO 24701 A 121 03 - Commodity/Materiel Development-Human Factors Engineering.

1. Establishment of Design Criteria for Communication Equipment Based on Operator Needs.

The need for data from actual operators of communication equipment to aid in ints human engineering design became apparent during the preceding year as a result of reports from SEA. A preliminary questionnaire was worked up and given to 50 SEA veterans to determine its validity. Results are being analyzed. The questionnaire will be modified and several hundred veterans will be surveyed in cooperation with CDC and the John F. Kennedy Center for Special Warfare. Results will be analyzed and design recommendations applied to all equipments under development.

2. Study of the Effect of Ambient Noise Level on Operator Task Performance in Mobile Inclosures.

Data derived from a recent contract with Dunlap and Associates have yet to be reduced and analyzed because of personnel shortages and heavy workload in supporting the ECOM laboratories' R&D effort. It is planned to reduce and analyze the data and to publish a report of the findings for use by all designers. There are yet no adequate data for this purpose.

3. General Investigations.

Solution of general problems arising during the course of the supporting effort provided to USAECOM Laboratories. These problems cannot be specified in advance.

B. Human Factors Engineering Support to the USAECOM R&D Complex.

In addition to the conduct of R&D, the Human Factors Engineering Section, R&D Directorate, continues to support the USAECOM Laboratories through review of QMDO's, QMR's, SDR's, TDP's and CD's; provision of consultation to project engineers by specification review, bid evaluation, design plan review, visits to contractors to monitor HFE progress on hardware development, and equipment review; and conduct of specific applied research to validate recommendations made during early design. Average number of development contracts containing human factors engineering requirements is 85.

C. Task 1H1 34101 D 235 15 - Instrumentation. The following work is being conducted by the Avionics Laboratory:

1. Current Instrumentation Improvement Subtask.

This subtask is concerned with the improvement of instrumentation in current rotary wing aircraft through experimental and analytical engineering and human factors studies and the application of currently available techniques and state-of-the-art instrumentation. This subtask is broken down into 5 projects as follows:

a. Information Transfer Requirements -

Determination of Information Transfer Requirements for current rotary wing aircraft through analysis of mission, functions, task, information transfer for task and task transition and time-based crew loading plus it[illegible]ive experimental evaluation (through simulation). Program will be conducted for (1) Transport Aircraft, (2) Observation/ Command Post Aircraft, (3) Fire Support Aircraft, and (4) Surveillance/ Reconnaissance Aircraft.

Preliminary analysis of rotary wing mission segment instrumentation-to-pilot information transfer requirements will be undertaken. Data and conclusions will be used to implement experimental cockpit instrumentation Display/Control system modification project.

b. Crew Capability Under Stress -

Plan and direct a program to establish crew capability of Army's personnel resources under varying conditions and periods of stress in current rotary wing aircraft. Specific problems are: (1) Effects of Vibration and Noise on Visual Perception, Utilization and Motor Response, (2) Effects of Lighting Intensity and Color on Visual Performance, (3) Effects of above factors as a function of exposure, repetition and age, and (4) Derivation of crew response characteristics and performance curves.

Work to be undertaken in conjunction with HEL and ATAC involved the determination of Army crew performance particularly as pertains to visual perception as a function of the ambient vibration

spectra found in the cockpits of rotary wing aircraft. This will be accomplished through a survey of existing work and such joint human factors engineering program involving the analytical and experimental talents and facilities of ECOM, HEL and ATAC as may be necessary to supplement these findings. Data derived will provide inputs for subsequent derivation of crew performance curves and visual design data for future instrumentation displays to be used under severe vibration conditions.

c. Current Cockpit Information Transfer -

Investigation and evaluation of information transfer effected through current rotary wing cockpit display/control instrument arrays. This will be accomplished through experiments, analysis, and validation of data obtained from: (1) Time Based - Task Load Analysis, (2) Park Task, Fixed base helicopter cockpit simulation, (3) Full helicopter system dynamic simulation, and (4) Flight experimentation in RH-2 flying laboratory.

Program as outlined above to be undertaken in conjunction with HEL and Aviation School and HumRRO, Fort Rucker. Data and analyses will provide input criteria for design, modification of improved display/control instrumentation for current rotary wing aircraft.

d. Current Instrument Evaluation -

Experiment and comparative evaluation of current industrial instrumentation developments applicable to current rotary wing aviation. This will be accomplished through part task and full dynamic simulation and actual flight evaluation. Instrumentation to be investigated will include: (1) Conventional dial/pointer instruments for flight control, navigation and engine status, (2) Vertical (moving tape and moving pointer) instruments for flight control, navigation and engine status, (3) Vertical Situation Indicators, (4) Horizontal Situation Indicators, and (5) Flight Directors.

Experiment and evaluation will be undertaken on promising industrial instrumentation developments that become available. Information and data derived will be utlized to implement selected replacement of instrumentation for UH-1 type missions.

e. Experimental Cockpit Instrumentation Display/Control System Modification -

Based on data and conclusions developed in the foregoing current instrumentation improvement project and the experimental program utilizing simulators and the rotary wing flying laboratory, the test and evaluation of misssion profile versus modified cockpit system performance will be accomplished. Recommendations for format and system characteristics for further improved display/control instrumentation for current rotary wing aircraft (UH-1) will be developed from the test and evaluation data.

Cockpit simulation and modification for improved UH-1 instrumentation will be started in the latter part of FY-68 as data and conclusions are developed from other projects on information transfer, crew capability and evaluation of industrial instrumentation developments.

2. Advanced Instrumentation Applications Subtask.

This subtask is concerned with the advanced development of Functional Display/Control Components and Techniques and Integrated-Function Display/Control Systems for advanced rotary wing aircraft now under development or planned. This involves investigations in the areas of human factors, analysis, integration of avionics sensor outputs into man-machine display/control systems, and the exploration of new instrumentation components and techniques. This subtask is broken down into 2 projects as follows:

a. Advanced Functional Display/Control Components and Techniques -

A program for the advanced development for rotary wing aircraft now under development or planned of functional display/control components and techniques for Navigation; Flight Control, Take Off, Hover and Landing; and Tactical Information Displays will be undertaken. This will involve consideration of Electronic, Solid State and Optical data presentation methods; techniques of data generation and control; symbology; data requirements; scanning patterns; physical constraints, etc.

Work will continue on advanced development, test, and evaluation of the AAAIS - developed vertical and horizontal situation displays as well as on the central computer complex required to generate and control the display patterns. Furthermore, based on data derived from various JANAIR programs such as Formation Flight Displays, UCAD, Steep Landing Displays, etc., a project for the advanced development of Flight Control, Take Off, Hover and Landing Displays will be undertaken late in FY-68.

b. Integrated-Function Display/Control Systems -

Since the Army requires rotary wing aircraft to perform the distinctly different missions of Observation, Reconnaissance, Fire Support, Cargo Transport and Personnel Transport, the needs of each class of these low performance aircraft for cockpit display of Flight Control, Tactical, and Navigation Information, etc., vary widely - and, for most effective crew performance, Integrated-Function Display Panels must be devised for each aircraft type which is optimal for the execution of its assigned mission. In order to accomplish this in an orderly fashion for the next generation of these aircraft, an exploratory and advanced development program for Integrated-Function Display/Control Systems for the following configurations will be undertaken: Observation Aircraft, Reconnaissance/Surveillance Aircraft, Fire Support Aircraft, Cargo Transport Aircraft, Personnel Transport Aircraft.

The first program for the development of an integrated-function display/control system will be directed toward the rotary wing transport instrumentation configuration. This effort will start late in '68 and will be based on data derived from several JANAIR programs such as ICRP, Theory of Manual Control, Geographic Orientation as well as on the information transfer and crew capability subtasks undertaken under the Current Instrumentation Subtask.

3. The following contracts are partially funded by the Army under the Joint Army-Navy Aircraft Instrumentation Research program (JANAIR) and are monitored by the Avionics Laboratory:

	Contract Title	Firm	Date Start.	Date Est. Completion
a.	Geographic Orientation	Human Factors Research, Inc. Nonr 4218(00)	June 1963	Continuing

This task seeks to identify pilot's perceptual cues as used to maintain or reacquire geographic orientation and to relate these cues as used for determination of optimum display techniques and display symbol encodement. Particular emphasis is placed on determing the pilot's visual references in the flight requirement of low altitude and high relative speed over terrain. It is in this area where pilot geographic orientation is most vital and where disorientation is most severe.

b.	Integrated Cockpit Study	Litton Systems, Inc. Nonr 4951(00)	May 1965	December'67

This task is to conduct a research study which will consist of analysis and experimentation to determine the optimum match between human capabilities and system requirements in a complex integrated avionic system environment. A main objective is the integration of pilot information displays and controls into a total avionic system. In order to expand the potential capabilities of integrated displays, additional knowledge is necessary to further reduce crew workload factors. The work covered will be directed toward an avionic system integration applicable to the FY-73-78 period.

c.	Terrain Following Display	Cornell Aeronautical Labs Nonr 4893(00)	May 1965	August '67

This task is an attempt to attain an optimal display system for the display of the information necessary to permit monitoring of automatic flight in a terrain following mode as well as safe manual flight in the same mode. The research is to be a human factors evaluation of those factors necessary to development detailed specifications, through the use of analysis and simulation, for the design of a display system.

d.	Visual Requirements for Head-up Displays	Sperry Gyroscope Co. Nonr N00014-66-60144	April '66	Oct 1967

This is an experimental research program to define the visual requirements relating to the design of wide-field, virtual-image optical projection display systems and visual phenomena which may compromise the effectiveness of these displays. The phenomena to be investigated cover all the relevant aspects of binocular disparity, retinal rivalry, and monocular and binocular viewing of the display. Included are techniques for alleviating retinal rivalry, the effects of a real world background, and size of exit pupil and freedom for head movement.

The program is designed to contribute specific knowledge to be used in evaluating operational acceptability and design of wide-field head-up displays in future military aircraft in lieu of the current narrow-field, gun-sight type of display.

e.	Formation Flight Display Study	Minneapolis Honeywell, Inc. ONR NOO 14-66-C0362	July 1966	July 1968

This research task required in this study is to investigate concepts and technology applicable to the display of aircraft formation flight information and to define the parameters of a suitable display system and technological requirements for tactical formation flight under all-visibility (i.e. flyable IFR) conditions.

f.	Theory of Manual Control	Systems Technology Inc. Nonr C0072	April 1966	Sept. '67

There is a continuing need for a cockpit design methodology yielding optimum control-display designs from an engineering standpoint. A preliminary theory of manual control has been evolved which is believed to provide a basis for the required engineering approach. It is the intent of this program to refine the theory, and develop it for systematic application as a means of establishing display requirements, and for assessing the relative merits of various displays of flight and navigational information to pilots. The refined theory will be subsequently applied to a specific control problem to validate results.

g.	Contact Analog Display Evaluation	US Navy Missile Center	April 1966	Continuing

This task is the determination and experimental evaluation of parameters and conditions for aircraft contact analog displays and

minimal and optimal visual and perceptual characteristics of displayed elements. A contact analog display generator developed in previous work under this sub-project is being used in these experiments. A six-degree-of-freedom aircraft cockpit simulation was installed and completely checked out by early spring of '67 and is now in operation.

This facility is located at the Human Factors Engineering Laboratory at the Naval Missile Center, Point Mugu, Calif.

This research will provide a scientific foundation of data and knowledge for application in specifying display information requirements to meet particular Naval aircraft missions. The knowledge of basic optimum characteristics for multi-parameter aircraft displays, (Vertical Contact Analog Displays (VCAD), will allow the improvement of the pilot's discrimination ability; and therefore, assist in the prevention of overloading his information processing capacity.

h.	Information Requirements for Electronically and Optically Generated Displays	MATRIX Corp.	May 1967	Nov 1967

This research task is part of a broader research program which will delineate optimum symbology and display characteristics for electronically and optically generated aircraft flight crew information displays. This study will evaluate and, where possible, validate symbology requirements for electro/optical displays by investigating, for existent operational and research display systems, parameters such as display size and location, information integration, display relation to aircraft controls, lighting techniques, and size, type and motion patterns of symbols. This task goal is to determine from prior work, electro/optical information requirements and specific areas and parameters where further analytical and experimental validation is needed.

Virtually all future Army and Naval aircraft will employ electronically and optically generated displays to present flight control, navigational, or target information to flight crews. A detailed evaluation of experience and experiment with such Navy and Army aircraft displays is necessary to define the best symbology to ensure mission accomplishment and to minimize accident potential.

i.	Aircraft Displays for Steep Approaches	Successful bidder	August 1967	Sept. '68

This project will determine aircraft display characteristics, including status, command and emergency information, to permit all weather steep angle approaches with rotary wing and V/STOL aircraft. The approach angles studied will be greater than 14 degrees. The study will include data sensing rates and accuracies and, if necessary, data transformations. The influence of failures to all or any part of the system will be investigated to determine back-up or redundant display requirements. In addtion, this study will examine the influence of (a) single versus formation flight, (b) ground and/or sea and self-contained landing systems, (c) tactical data and control systems; on display configurations and characteristics. The display system sought will enable manual as well as automatic control for IFR steep angle approaches to a landing at fixed as well as tactical sites.

The aircraft display system envisioned will reduce the sensitivity of tactical vertical envelopment of maneuvers to indigenous and enemy fire power (ground fire) and permit more expedient air operations through simultaneous approach/landing and take-off/departure of military aircraft from developed as well as undeveloped landing sites.

	Task	Experimenters	Date Start	Est. Compl.Date
D.	1Lo 13001 A91 A36 01 Cutaneous Sensitivity Communications	H.S. Bennett J. McCray H.F. Burkhard Comm/ADP Lab J.R. Hennessy Avionics Lab	November '64	Oct '67

The technical objective is to determine the possibility and practicality of utlizing the reception of relatively narrow-band information through the cutaneous channels as a reinforcement technique for badly distorted information presented to the operation via conventional terminal equipments over visual or auditory channels. There are three phases to the study. Phase I (completed) was concerned with the design of transducers and the determination of the optimum location of these transducers. Phase II, or the experimental phase, consists of data collection and is now 90% completed. Data are still to be secured on methods of increasing acuity.

E.	1H6 20501 A 484 04 02 Cutaneous Communications	J.W. McCray Comm/ADP Lab	July 1965	Dec 1968

This investigation is aimed at using data secured from Task 1LO 13001 A91 A36 01 to assist in the design of field type equipment for cutaneous communications.

F.	1H6 20501 A 484 01 05 Speech Intelligibility Evaluation	J.W. Preusse Comm/ADP Lab	Aug 1966	Jul 1967

A speech intelligibility evaluation of five vocoders in a total of ten modes of operation was recently conducted, using the Fairbanks Rhyme Test. Fourteen inmates of Holmesburg Prison, Philadelphia, Pa., were used as test subjects. In addition to providing much detailed information about the vocoders, the evaluation demonstrated the efficiency of the Fairbanks Rhyme Test in discriminating among vocoders of high intelligibility. The results further show the feasibility of using prision inmates as test subjects.

G.	1Lo 13001 A91 A04 01 Cinefluorographic Analysis of the Vocal Tract	J.L. DeClerk Comm/ADP Lab	Jan 1963	Sept 1967

When tomograms are obtained, it is important to know the amount of tissue in focus and the level which the radiography depicts. A technique is presented to measure these factors. A test object with adjustable lead numbers and a specially constructed book cassette were designed and fabricated.

When the book cassette using seven films was used in conjunction with the Massoit Polytome, it was possible to accurately show the anatomy of the upper airway. These simultaneous multi-directional tomographs are presented to show how area functions of the upper respiratory tract can be extracted.

H.	1H6 34301 D 246 03 26 High Ambient Noise Microphone (Tissue Micorphone)	J.L. Declerk A.L. Marsella Comm/ADP Lab F. DiMattia A. Rosenheck CBL Lab	April '67	Sept '68

The technical objective is to develop an improved microphone for use in high noise and high wind environments such as encountered in helicopter service. The microphone will be a contact type with contact to be to the wearer's head and will be compatible with Army protective headgear and masks.

2B. U. S. ARMY MATERIEL COMMAND HUMAN ENGINEERING LABORATORIES

Aberdeen Proving Ground, Maryland

A. CURRENT WORK PROGRAM

1. Systems Research

The work program of the Systems Research Laboratory falls into three broad, related categories:

Concept weapon feasibility and effectiveness analysis.

Application of human factors engineering data to materiel in the RDT&E cycle and monitoring of industrial contractors.

Human factors engineering data storage and retrieval, and preparation of human factors engineering guides, standards and specifications.

a. Concept Feasibility Analysis:

The continued process of maintaining the defense posture of the U.S. Army through increasing the effectiveness of materiel gives rise to materiel objectives, which, in turn, call forth many new and novel concepts. Concepts, however, must be evaluated against other concepts, existing materiel, and current developments to determine the significance of the concept.

In the past materiel concept evaluations were predominantly physical and mechanical in nature with no due concentration on the man-operator requirements. This, in part, was due to the lack of data in usable form to be used in the evaluation.

In order to overcome the deficiencies of the evaluation process experimental studies are conducted to derive detailed behavioral data in direct support of a specific concept or class of concepts.

The approach followed is to perform detailed analyses of new materiel objectives or concepts to define and isolate the critical man-task requirement underlying the objective or concept. The initial analyses are used to answer the feasibility of using the human operator in the various tasks and determining the design aids required for enhancing the operator's role. When necessary, detailed experimental studies are performed to develop operator task tolerances. These data are then coupled with physical data to perform total weapon evaluation studies.

Current work in the area of concept analysis is:

Task	Experimenter(s)	Date Started	Estimated Completion
Lightweight Mortar Analysis	Weapons Branch	1967	Continuing
LAW Concept Analyses	"	1966	"
Signature I. (Detection of Target Signatures)	"	1967	"
40mm Concept Weapons	"	1966	"
Silent Weapons	"	1966	"
Troop Postures in Combat	"	1966	"
Main Battle Tank	"	1965	"
Aircraft Tracking Aid Devices	"	1964	"
Mechanized Infantry Combat Vehicles	"	1965	"
Small Arms	"	1964	"
Side Arms	"	1965	"
Night Vision Devices	"	1965	"
Army Area Communications System	Missile Branch	1965	"
Engineer Equipment	"	1965	"
Human Factors Contributions to Systems Availability	"	1965	"
SAM-D System	"	1966	"
Tactical Automatic Switchboard	"	1967	"
Avionics	Aviation Branch	1966	"

Task	Experimenter(s)	Date Started	Estimated Completion
Advanced Aerial Fire Support System (AAFSS)	Aviation Branch	1965	Continuing
Advanced Army Instrumentation System (AAIS)	"	1965	"
Flight Handling Qualities Research	"	1966	"
Cockpit Displays & Lighting	"	196[illegible]	"
VSTOL Aircraft	"	1966	"
Voice Warning Systems	"	1967	"
Aircraft Body Armor	"	1967	"
Surveillance & Target Acquisition Aircraft System (STAAS)	"	1966	"
Flattop	Tech Spec Ofc	1966	Continuing

b. Application of Human Factors Engineering Data and Monitoring of Industrial Contractors:

This work area follows the in-house feasibility studies and begins at the time that proposals for R&D on major weapon systems are solicited from industrial contractors. During the proposal preparation, the Human Engineering Laboratories (HEL) provide consultation and data to all proposing firms through the medium of bidders' conferences and individual meetings. Following the submission of final proposals, the HEL become a part of the technical evaluation committee formed to select the best proposal for development. Following the selection of contractor, the HEL monitors the contractor's efforts in the application of human factors data, in addition to performing those research studies required to establish a position for the contractor in unforeseen problem areas, and conduct various human factors evaluations on components and subsystems as they become available.

The predominant efforts are devoted toward insuring the compatibility of equipment design with the operational concepts and the intended user population. Thus, from the initial task and skill analysis, proposed designs are reviewed to insure compatibility with the operator, stressing such aspects as controls-displays; information flow; ambient and internal environment (including heat, noise, vibration, various gases, etc.); accessibility, maintenance and checkout requirements; operational procedures for emplacement and displacement; etc.

This work is normally carried on through ET and UT. Systems falling within this work area are:

Truck Series	Missile Branch	Continuing
LANCE	"	"
NIKE-X	"	"
MTV	"	"
Land Combat Support System (LCSS)	"	"
PERSHING	"	"
TOW	Weapons Branch	"
CHAPARRAL	"	"
Forward Area Air Defense System (FAADS)	"	"
Medium Assault Weapons	"	"
Aircraft TOW-SHILLELAGH	Aviation Branch	"
Light Observation Helicopter (LOH)	"	"
CL-84	"	"
Composite Aircraft Program (CAP)	"	"
Remote Target Designation System (RTDS)	"	"
Development of Flight Standards	"	"

c. <u>Information Retrieval, Analysis and Design Guide Development</u>:

The first objective of this work area is the accumulation, storage, retrieval, and dissemination of the information and data of human factors engineering and related topics. These data form the basis for the design guide development and point to areas where information is lacking. A major aspect of this work area is the development of a human factors engineering language for use in indexing for storage and retrieval.

Current work in this category:

Task	Experimenter(s)	Date Started	Estimated Completion
HFE Bibliographic Series, Volume 1	Technical Specifications Office	1965	Continuing review & updating
HFE Bibliographic Series, Volume 2	"	1966	"

The second objective of this work is the development of specific documents which serve as human factors engineering specifications, standards or guides for use during an RDT&E cycle by in-house development agencies and their industrial contractors. The preparation and updating of these documents is dependent upon the availability of research data which can be translated into design requirements.

Current work in this category:

Task	Experimenter(s)	Date Started	Estimated Completion
S-1-63B, Maximum Noise Level for Army Materiel Command Equipment	Technical Specifications Office	May '63	Continuing review & updating
S-2-64, Human Factors Engineering Design Standard for Vehicle Fighting Compartments	"	May '64	"
S-3-65, Human Factors Engineering Design Standard for Missile Systems and Related Equipment	"	Jan '65	"
S-4-65, Human Factors Engineering Requirements for the Development of US Army Materiel	"	Jan '65	"
S-5-65, An Evaluation Guide for Army Aviation Human Factors Engineering Requirements	Aviation Branch	Jan '65	"

Task	Experimenter(s)	Date Started	Estimated Completion
S-6-66, Human Factors Engineering Design Standard for Wheeled Vehicles	Technical Specifications Office	Jun '65	Continuing review & updating

d. Program Monitoring and Training:

As the central US Army Materiel Command human engineering agency, the Human Engineering Laboratories are required to provide monitorship of the total AMC Human Factors Program, in addition to providing necessary human factors engineering traning for commodity command personnel. This program has been implemented in the following manner:

(1) Specific coordination meetings called by the HEL to determine current status where more than two organizations are contributing, e.g., meetings called by HEL to review the planned and programmed work in the field of aviation by USABAAR, MOCOM, MICOM, etc.

(2) Attendance at in-process reviews of all major items under development as required by AMC letter, 20 November 1962, subj: In-Process Reviews. In-process reviews assure the coordination between subordinate commands, human factors units, and the HEL.

(3) Aiding subordiante command human factors engineering units by performing equipment analysis and evaluation and contractor monitoring when the workload is beyond their internal capabilities.

(4) Visiting the subordinate command human factors units to insure coordination of their efforts on specific major weapon systems and in research.

(5) Human factors engineering training. During FY 67, the HEL offered the 40-hour HFE orientation course seven times and the 2-day course five times. During FY 66, 225 personnel took these courses at HEL; 240 students took the courses during FY 67--making the total participation for FY 66-67: 465. In addition to offering the courses again in FY 68 at HEL, the Arctic Test Center, Ft. Wainwright, Alaska, has requested that the 40-hour course be given at Ft. Wainwright to approximately 50 test engineers in August 1967. A total of 327 students are scheduled to take these courses at HEL during FY 68.

2. Supporting Research

The Supporting Research Laboratory conducts all of the basic research within the Human Engineering Laboratories (HEL). This program is designed to establish human capabilities and limitations under a wide variety of operational and environmental conditions.

Task	Experimenter(s)	Date Started	Estimated Completion

Ten research teams have responsibility for the following tasks:

a. Relationship of Hearing Changes to Acoustic Inputs	Price	Jul 66	Continuing

The objective of this task is to establish the relationships between acoustic inputs, immediate hearing losses, and recovery from such loss.

Efforts in the next year will involve experiments correlating the size, extent and rate of acquisition of electrophysiologically measured hearing losses with sound parameters (frequency and intensity). Subsequent efforts will see attempts to define the physiological bases of acoustic trauma and the recovery processes that may accompany them.

b. Human Responses to Pulsing Auditory Inputs	Hodge McCommons	Jul 66	Continuing

The primary objectives of this task are to further investigate human response to pulsing auditory inputs, of both potentially-hazardous and non-hazardous types, and to utilize new information to formulate a more comprehensive damage-risk criterion for impulse-noise exposure.

FY 68 effort will include the following: (1) additional study of the growth of temporary threshold shift (TTS) from impulse-noise exposure; (2) determination of recovery functions for impulse-noise-induced TTS; (3) study of the relation between impulse-noise parameters (peak level; duration) and the growth of TTS; and further laboratory investigation of temporal auditory summation and variables affecting Bekesy thresholds.

c. Behavioral and Physiological Responses Under Chronic Stress	Levine	Jul 66	Continuing

The major problem involved in this task is a further explication of the effect of "phychological stress" in altering an organism's behavior. Interest here is directed toward situations where changes in behavior endure well beyond the time of stress.

Of specific interest are the attributes of a stimulus which established it as a stressor, as well as the necessary contingencies in the interaction between the stimulus and the organism needed to establish a behavioral and physiological change. Modified shock avoidance and sleep deprivation paradiagms will be used for stressors. Careful attention

and controls will be utilized to assure that the animals are under psychological not physical stress.

Task	Experimenter(s)	Date Started	Estimated Completion
d. Endocrine Response to Transient Psychological Stressors	Hudgens	Jul 66	Continuing

The objective of this project is to determine the nature of the involvement of the endocrine systems and of early experience in the organism's response to transient psychological stressors.

e. Cross-Sensory Channel and Cross-Sensory Modality Interactions	Gordon	Jul 66	Continuing

This project is designed to develop a parametric analysis of human and animal performance under conditions of sensory overload, sensory sharing, and cross sensory channel--cross sensory modality interactions. In this project the distinction between cross sensory modality and cross sensory channel refers to the fact that the former implies two senses (i.e., auditory vs. visual; and the latter implies one sense, i.e., one vs. two ears). Three specific questions are of interest: (1) Under what conditions and to what extent is one sense modality superior to the other? (2) Can performance of a task controlled by one sense modality be carried on simultaneously with a task controlled by a second modality? (3) What are the differences between cross sensory channel interactions and cross sensory modality interactions?

f. Keeping Track of Sequential Events	Monty	Jul 66	Continuing

The ability of man to follow a changing series of events by keeping track of it in his head is a relatively new field of study. Previous research has indicated that keeping track performance cannot be predicted on the basis of current theories of short and long term memory. The objective of this task, is to (a) determine how well man can mentally keep track of the present state of a changing situation and (b) define the short term memory and perceptual processes underlying this behavior.

g. Social Anthropological Research	Keyser	Jul 66	Continuing

The prime objective of this work unit is to define and analyze the social, cultural and anthropological variables which mitigate against effective use and maintenance of modern weapon systems.

	Task	Experimenter(s)	Date Started	Estimated Completion
h.	The Conditioning of Attitudes to Unfamiliar Items of Information	Carriero	Jul 66	Continuing

The objective of this task is to examine the relative effectiveness of two techniques of reinforcement in producing attitude conditioning and also to determine whether the techniques differentially affect a subject's ability to verbalize the reinforcement contingency. A third goal is to determine whether conditioning to "uncertainty" engendered in a different context (e.g., a psycholphysical discrimination task) will transfer to questionnaire situations.

In addition an examination will be made of the ease of conditioning under situations where the effective loading of the concept and statement about the concept stand in congruent and incongruent relation to each other. In other words attempts will be made to induce conditioning where the concept has a positive valence and the statements about the concept have a negative valence and vice versa as well as under conditions where both concept and statement have the same valence.

i.	Thermal Energy Exchange between Men and their Environment	Woodward	Jul 66	Continuing

The objective of this project is to develop methods of assessing radiant heat exchange between men and their environment to identify the prime environmental factors which are responsible for different manifestations of thermal stress.

3. Engineering Research Laboratory

The Engineering Research Laboratory is composed of four branches: Design Engineering, Electronic Development, Acoustical, and Experimental Shop. There is also a technical photographic facility. The primary purpose of this laboratory is to provide general and specialized support for the Systems and the Supporting Research Laboratories. Examples of this support are depicted in the following projects/studies in which this laboratory has participated:

a. Development of an automatic gun rammer concept.

b. Dynamic evaluation of TV and optical tracking systems for tanks.

c. Series of experimental gun sights for night firing.

d. Optical aiming error data collection system for small arms evaluation.

e. Instrumentation for testing night vision acuity.

f. Supersonic projectile study.

g. Subsonic projectile study.

h. Communications criteria standard.

i. Impulse noise discrimination and localization study.

j. Noise evaluation for LANCE system.

k. Weapon attenuation device study.

l. PERSHING communications criteria.

m. Noise evaluation of communication shelters.

n. Quick-fire stress study - Instrumentation, controls and equipment.

The laboratory also initiates and conducts research projects that require singular and specific engineering applications to the overall human factors engineering mission of the Human Engineering Laboratories. Typical of these efforts is the continuing research in the field of muzzle blast attenuation and small arms silencers.

2B. U. S. ARMY MATERIEL COMMAND MISSILE COMMAND

Redstone Arsenal, Alabama

	PROJECT	CONTRACTOR/ACTIVITY
a.	CHAPARRAL	AERONUTRONIC MICOM

HFE evaluations of gunner's and observer's environments, during firings from CHAPARRAL EM-1, were conducted and are continuing. HFE inputs to design changes were made for improved interior control-display panels. Drafts of operating procedures were prepared and time-line studies were conducted. Preliminary sound surveys were undertaken and the results analyzed. Work station layout analyses were completed on the OMSS and SMSS and findings incorporated into design. Road tests were performed to determine mount seating requirements. Future tests will determine optimum cab seating arrangement, missile reload operations, and vehicle mounting aids. This HFE effort is continuing.

b.	DRAGON	McDONNELL

This year, the first phase of mockup testing was completed. These tests were performed with the preprototype launcher configuration and a preliminary support stand. Time studies were completed for: (a) launcher setup and assumption of firing position, (b) tracker removal and launcher discard, and (c) installation of tracker on new round and fire preparation. Other mockup evaluations tested various locations for tracker, bipod, trigger, handle, sling, and telescope sight. Studies were completed for trigger configuration, cocking and trigger forces, and reticle pattern requirements. A preliminary HFE evaluation was made of the Sequencer Control Panel, located on the Test Conductor Control Console. Tests were conducted to obtain preliminary qualitative data on problems associated with firing under starlight illumination. Plans are under way to further investigate effects on target detection resulting from side thruster firing after sunset. Other HFE tests and evaluations planned for the next reporting period include sound pressure level and overpressure data collection and analysis, recoil simulation tests, and tracking tests. Operational studies will evaluate weapon design as measured by gunner reaction time in the four firing positions.

The DRAGON HFE program is a continuing effort.

c. Dod Standardization Program — MICOM
Project MISC-0421 — HEL

The objective of this program is to consolidate all Army, Navy, and Air Force military specifications for human engineering into a single, fully coordinated military specification, "Human Engineering in Development of Military Systems, Equipment, and Facilities." The scope of this specification extends across all materiel developments requiring application of a human engineering program. The Army Missile Command has been designated preparing activity and the Naval Air Systems Command and the Air Force Systems Engineering Group have been designated departmental custodians for this project. This effort was initiated in September 1966 and is scheduled for completion during FY68.

d. Dod Standardization Program — MICOM
Project MISC-0422 — HEL

The objective of this program is to consolidate all Army, Navy, and Air Force human engineering design requirements into a single, fully coordinated military standard, "Human Engineering Design Criteria for Military Systems, Equipment and Facilities." The scope of this standard extends across all materiel development items. The Army Missile Command has been designated preparing activity and the Naval Air Systems Command and the Air Force Systems Engineering Group have been designated departmental custodians for this project. This effort was initiated in September 1966 and is scheduled for completion during FY68.

e. LANCE — LTV
HEL

During this reporting period, HFE evaluations and studies were conducted on the LZL and adaption kit, fire device indicator lamp logic, umbilical mating problems, GSE interfaces, basic vehicle, launcher, sighting, and laying. HFE requirements were developed for the Simulated Arctic Test Plan (Eglin), TP Operational Field Tests (Ft. Sill) and Tropic Test Plan. Human Factors support of the Simulated Arctic Test and TP Operational Field Test were completed and inputs to the final reports submitted. LANCE TP vehicle sound surveys were conducted and analyzed, and preliminary launch noise evaluations were undertaken. CSTS preliminary operating procedures and fault isolation sequences were prepared. LANCE HFE design and test efforts are continuing.

f. LCSS — MICOM
HEL

During the current reporting period, workspace layout, panel design, and operator task evaluations were conducted in conjunction with Inspection and Demonstration Tests. Acoustical evaluations and speech intelligibility tests were completed for the Repair and Storage Group (RSG-1) and the Electronic Test Group (ETG-3). Future HFE efforts

on LCSS will support the quality assurance and test programs.

g. M-22 Improvement Program — Norman K. Walker Associates, MICOM

The objective of this program is to ascertain the degree of tracking performance enhancement, if any, through substitution of a thumb-operated, force-type controller with aided tracking network for the standard SS-11 displacement-type controller. The first segment of this study consisted of a laboratory experiment to compare the two controllers and thereby establish advisability of field testing. The results of the experiment, supplemented by analytic and subjective evaluations, as well as results of similar studies, disclosed that there are no compelling reasons to believe that tracking performance cannot be enhanced through substituion of the thumb-controller and aided tracking network for the displacement type controller. A flight test series, using training missiles, was recommended to establish the value of the new controller and aided tracking network in a field environment. A second study is now being performed to investigate the rapid training of operators for the M-22 system using the DX43 simulator. The program was initiated the first quarter FY67 and is continuing.

h. NIGHT LIFE — RCA, MICOM

The principal experimentation performed on this program is a contractor effort. Final human factors testing is a responsibility of the MICOM Human Factors Engineering element which also furnishes inputs to the program in the areas of system evaluation, contract monitoring, and design assistance. Details of the program and the human factors efforts are classified.

i. NIKE X — BTL (and subcontractors), MICOM, HEL

MICOM and HEL furnish consulting services to the NIKE X Project Office in the areas of system evaluation, contract monitoring, and design assistance from the HFE viewpoint.

j. PERSHING — MARTIN-ORLANDO, HEL

During the past year, HFE evaluations were performed on the PERSHING 1a Improved Programmer Test Station (IPTS), Systems Components Test Station (SCTS), and the Battery Control Center (BCC). IPTS acoustic design requirements were generated; noise levels produced by the air conditioning subsystem were measured and analyzed; and speech intelligibility tests were conducted to determine the effectiveness of the PERSHING 1a communications equipment in the local noise environment. Workspace layout and equipment arrangement studies were performed on the SCTS van. A BCC mock-up was fabricated and subjected to a detailed HFE assessment. The PERSHING 1a HFE Program is a continuing effort.

k. SAM-D MICOM HEL

MICOM and HEL furnished HFE advisory support to the Project Manager's Office during Contract Definition and assisted in the source selection process. A study of man-display interaction was initiated to develop specific human engineering criteria for the displays and information processing equipment for this system. The HEL are conducting these studies utilizing simulation equipment developed by MICOM. During the current reporting period, nine study areas were identified for investigations to define the criteria for the man-display interface for the SAM-D Program. This effort is continuing

l. TOW/HELICOPER HUGHES AIRCRAFT CO.

An evaluation of the compatibility of the man and his personal equipment with the TOW/H cockpit equipment, as installed in the UH-1B helicopter, was performed utilizing a mock-up. Other evaluations were completed on the handgrip, stabilized sight controls and status light displays, cross hair illumination and eyecup/headrest design. Sound pressure levels were recorded and analyzed from experimental firings conducted at Redstone Arsenal. Pilot steering display studies, utilizing simulated helicopter control loop dynamics, were carried out to determine the effect of display scaling and rate damping on task performance. A study was also conducted to compare fine tracking performance of a viscous damped, spring-centered, pencil type controller to the same stick with the damping fluid removed. No significant differences in performance between the damped and undamped controller configurations were observed. During the next reporting period, a field test will be conducted to validate the results of the laboratory experiment. The TOW/H HFE program is a continuing effort.

m. TOW HUGHES

An HFE evaluation of TOW scoring unit requirements was undertaken to insure effective training of gunners to accurately track targets from acquisition through missile launch to missile impact. An analysis of gunner audiometric data was performed for gunners who participated in the TOW firing program. The data, collected over a period of 22 months, disclosed no deleterious effects dur to firing. An HFE evaluation was conducted to examine the operational characteristics of the launcher subsystem and to demonstrate that the system meets handling and tracking performance requirements. Specific items of interest were night operational capability, first echelon maintenance, and tracking performance while the gunner is wearing a CBR protection mask. As a part of the TOW/M-113 vehicle integration tests, an operational handling evaluation was conducted to evaluate M-113 vehicle installation of the TOW Launcher, and to conduct time trials for the operation of the launcher in the vehicle, with special attention to the compatability of the TOW system operations with normal vehicle operating procedures. The TOW HFE program is a continuing effort.

n. Investigations of Weapon Systems Concepts for the 1975-85 Time Frame — MICOM

The human factors engineering element is participating in this effort, the objectives of which are to define technology baselines, formulate weapon system concepts for the 1975-85 time-frame, perform performance and cost data analyses, evaluate weapon systems on a technology basis, and recommend R&D programs. During the current reporting period a survey was made of current indirect fire SSM systems to ascertain primary HFE problems having a multisystem implication. These problems were analyzed from the standpoint of remedial action requiring change in system concpt or advance in the state-of-the-art. Analysis of these HFE problems yielded a limited "Technology Base" delineating characteristics and penalties of current HFE problems, means of correcting the problems, and anticipated levels of improvement. This effort was initiated during the last quarter of FY67 and will continue.

2B. U.S. ARMY MATERIEL COMMAND
TANK-AUTOMOTIVE COMMAND

Warren, Michigan

The current human factors engineering activities within the Advanced Vehicle Systems Laboratory are as follows:

a. Task: Human Factors Engineering on Armored Reconnaissance Scout Vehicle
Experimenter: Simon J. Grabowski
Date Started: March 1966
Estimated Completion: Continuing

Vehicle concepts from several contractors have been analyzed and evaluated. The results from the evaluation are being utilized in a parametric cost effectiveness study.

b. Task: Human Factors Engineering on the Unarmored, Howitzer, 155mm
Experimenter: Simon J. Grabowski and Engineering Staff of Human Engineering Laboratories, Aberdeen Proving Grounds, Maryland
Date Started: August 1965
Estimated Completion: Continuing

The loading study and spade implacement in soil evaluation were completed on the test rig, and an informal report was written and forwarded to the project engineer in ATAC.

Additional concepts of the gun system were formulated at ATAC and analysis and evaluation of the concepts were conducted.

c. Task: Study to determine need of detector and alarm for toxic gases in combat vehicles
Experimenter: Simon J. Grabowski
Date Started: September 1966
Estimated Completion: May 1968

This project has been delayed due to long lead time in purchasing of instrumentation during FY 67. It is expected that the project will start during August 1967. The study will determine levels of Carbon Monoxide, Ammonia, and Oxides of Nitrogen in an M60, Medium Tank, during firing of weapons and during various phases of vehicle mobility.

d. Tasks: Standards, specifications, formal vehicle proposals and proposals pertaining to vehicle components are reviewed and evaluated as need arises.

2B. U.S. ARMY MATERIEL COMMAND MOBILITY EQUIPMENT COMMAND

Center Line, Michigan

U.S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA

A. CURRENT WORK PROGRAM:

1. Engineer Studies and Investigation, Camouflage
(Project No. 1M624101D46701)

Task	Experimenter(s)	Date Started	Date Completed
a. Evaluation of Solor Heat Reflecting Paints for Reducing Thermal Stress	John H. Hopkins, Ch David L. Gee, Phy Camouflage Branch, Combat Research Lab SMEFB-MC, USAERDL Ft. Belvoir, Va. 22060	Aug '66	Sept '66

Study has been completed and reported in USAERDL Technical Report 1886, dated January 1967.

2. Marine Craft
(Project No. 1M443012D256)
Task 11, Lighter, Beach Discharge, Deck Cargo, Mark II

Task	Experimenter(s)	Date Started	Date Completed
a. Lighter, Beach Discharge Deck Cargo, Mark II	Emmett G. Hundley Marine & Bridge Lab. Military Technology Department, USAERDL, Ft. Belvoir, Va. 22060	Dec'64	April'66

Naval Ship Systems Command Design Work Study Techniques were used to establish manning requirements for both operation and maintenance of the lighter. Through the uses of preventive maintenance analysis, activity sampling aboard the BDL-1X and operational sequence diagrams, human responses were integrated into the various hardware systems of the lighter.

The controlling operational condition was determined and operational and maintenance manning requirements, both for skilled and unskilled personnel,established. By diagramming the functions to be performed by personnel at each operational station in the operational sequence diagram, a logical grouping of controls, communication and instrumentation was attained.

In a lighter where the crew must live below the main deck, living conditions in the tropics would be intolerable. To improve these conditions, berths and messing spaces have been air conditioned. This improved operational efficiency and crew morale.

Under normal operational conditions, there would be five diesel engines running in the engine room. This would result in a very high noise level. Also, the ambient temperature would be high and might exceed 120 F in the tropics. To limit exposure of personnel to these conditions, an air-conditioned, acoustic-insulated watchstander's booth has been provided in the engine room.

All lighter control functions, including propulsion control, have been consolidated in a console located in the pilothouse. To limit the functions to be performed by the operator when the lighter is operating in congested areas or under conditions requiring a high degree of maneuverability, the console has been designed for either a one-or two-man operation.

Task 06, Boat Shallow Draft, for Counterinsurgency Warfare

Task	Experimenter(s)	Date Started	Date Completed
b. Boat, Shallow Draft for Counterinsurgency Warfare	John F. Sargent, Marine & Bridge Lab, Military Technology Dept. USAERDL Ft. Belvoir, Va. 22060	Mar '64	Mar '67

The development resulting from the requirements of Task 1M443012D25606 was the large airboat. This boat was powered by an air-cooled engine rated 400 hp at 2650 rpm. The engine drove an air-propelled, 78-inch diameter, 44-inch pitch, 4-bladed wooden propeller. A disadvantage associated with this type boat is the high noise level that the user and passengers are subjected to. At the operator's seat adjacent to the engine, a maximum noise intensity of 135 db was recorded. A study was initiated to determine and implement means of reducing the noise level to facilitate tactical usage as well as protect passengers and operators. This study was especially significant in consideration of increasing emphasis on air propulsion for Ground Effects Machines, Captive Air Bubbles, Commercial Airboats, and small tactical aircraft.

The study first established frequency and intensity spectrum of base airboat without attenuation devices for various engine speeds. Then, ignoring tactical significance since the user was indefinitive in spelling out a permissable sound level and since hull noises (approximately 60 db) could not be reduced, emphasis was placed on reducing sound level to one compatible with human endurance. In-house ERDL experiments in this area included incorporation of a special muffler used on aircraft and terminating the exhaust underwater. High frequency noises were reduced approximately 10 db and, of course, the resulting back pressure of approximately 10 psi on the engine exhaust system reduced the power available for propulsion. The noise reduction program conducted by Hydronautics, Inc. for ERDL included research study, model tests, and full-scale attenuation device development. Final results incorporated a multi-bladed propeller (16 blades) inclosed in a shroud (or nozzle). This configuration succeeded in lowering the level to approximately 110 db in the cargo well of the boat, but failed to meet Human Engineering Laboratory requirements of a minimum noise level of approximately 90 db at the higher frequencies and 115 db at the lower frequencies. Consequently, earmuffs and warning plates were required to protect the user from physiological damage.

Isolation of the user from the source of noise (such as a cab or deckhouse) was infeasible dur to the tactical necessity for quick response.

The report containing full details of the study by Hydronautics, Inc. is Number 532, dated June 1967.

3. Water Supply Equipment
(Project No. 1J643324D551)

Task 02 - Ion Exchange Unit, Mobile, 3000 GPH

Task	Experimenter(s)	Date Started	Date Completed
a. Ion Exchange Unit Mobile, 3000 GPH	Richard J. Gainey Sanitary Sciences Laboratory, USAERDL, Ft. Belvoir, Va.	July '62	June '69

Instruments, working area configuration, and chemical handling requirements have been service tested and found to be satisfactory. Tropic tests have been completed and equipment will be redesigned for a pod or modular mounting before shipment to Alaska for arctic tests.

Task 08 - Lightweight Water Purification Unit

Task	Experimenter(s)	Date Started	Date Completed
b. Lightweight Water Purification Unit	Raul Rodriguez Sanitary Sciences Laboratory, USAERDL, Ft. Belvoir, Va.	Apr '66	June '69

Engineer design tests have been completed with full consideration given to evaluation of human factors engineering. Procurement of ET/ST models is being initiated.

4. Materials Handling Equipment
(Project No. 1G643324D586)
Task 01, 4000 lb capacity, rough terrain forklift truck

Task	Experimenter(s)	Date Started	Date Completed
a. 4000 lb capacity, rough terrain fork-lift truck	Rod Hardy Mechanical Equipment USAERDL, Ft. Belvoir, Va.	Nov '62	June '60

The above vehicle was designed to provide a means for handling supplies over rough terrain, in unprepared storage areas, and at all handling echelons in the theater of operations.

The operation of the vehicle was designed to facilitate handling of palitized cargoe in a safe, efficient manner. Consideration has been given to the size and location of the driver's compartment and the controls to accommodate the 95th percentile operator when equipped with either temperate climate or arctic type clothing, including army type boots and mittens.

Consideration was also given to operator safety in the location of the driver's compartment and the ease of egress. Driver fatigue factors were utilized in the design of the steering and brake efforts and control locations for the best compromise of operator effort and feedback to provide a controllable, safe vehicle. The driver's comfort under arctic operation is a feature which is under continuous development which, in the particular vehicle, will consist of a personnel heater, a lightweight cab and a means for pre-heating the engine for ease of starting.

5. Fuels Handling Equipment,
(Project No. 1J643324D592)
Task 04, On-Shore Bulk Storage

Task	Expermenter(s)	Date Started	Date Completed
a. 10,000 Bbl Hasty Storage Reservoir	N.A. Caspero Fuels Hdlg Equip Div, ERDL Ft. Belvoir, Va.	Jan '65	July '70
1250 and 2500 Bbl Self-supporting Storage Tanks	N.A. Caspero Fuels Hdlg Equip Div, ERDL Ft. Belvoir, Va.	Jan '65	Jan '70

The above equipment was designed to provide a quick means for storage of large quantities of bulk fuel in the early stages of a military operation.

The reservoirs and tanks were designed to facilitate handling, transportation, and set-up. Lightness of weight features were incorporated insofar as compatible with serviceability. Incidence of exposure of personnel to the hazards of fuel spills was minimized insofar as possible.

Task 08, Pipeline Construction and Maintenance Family

Task	Experimenter(s)	Date Started	Date Completed
b. Radiographic Weld Test Set	W.S. Guerrant Fuels Hdlg Equip Div, ERDL Ft. Belvoir, Va.	July '65	Jan '70

The weld test set is a radiographic device which will be used to inspect the integrity of each weld in a welded pipeline system prior to pressurizing it with liquid fuels.

Human factors have been considered in design of the equipment. Adequate radioactive shielding has been provided. Air conditioning and heating equipment will provide a comfortable working atmosphere for operators in all temperature extremes. Lightness of weight of components has been incorporated into the design. Ease of access and operation of controls has been provided.

Task 09, Fuels Decontamination

Task	Experimenter(s)	Date Started	Date Completed
c. Filter/Separator Family	T. H. Jefferson Fuels Hdlg Equip Div, ERDL Ft. Belvoir, Va.	July '65	Jan '70

The military standard filter/separator family provides a capability for decontaminating heavily contaminated fuel to the cleanliness levels

demanded by present day aircraft and ground equipment.

Human factors have been considered in design of the equipment. Light alloys were utilized insofar as possible. Quick type head closures have been utilized to provide ease of access to expendable components. Controls have been mounted so as to be easily seen and actuated. Static discharge devices have been incorporated to minimize explosive hazards.

6. Environmental Control Equipment
(Project No. 1M643303D545)
Task 01, Engineer Studies & Investigations (Environmental Equipment Applicative Studies)

Task	Experimenter(s)	Date Started	Date Completed
Study of Environmental Systems for Helicopter AH-1G	R.E. Franseen Environmental Equipment Div, USAERDL, Ft. Belvoir, Va.	19 May '66	Oct '67

The Environmental Equipment Division provides consulting support, when requested by Army agencies, to aid in the design of potential environmental equipment applications. Human factors considerations usually form the basis for the application design along with consideration of waste heat removal from electronic equipment. Human factors which require consideration are maximum allowable heat stress for the required mission, air velocities near personnel, ventilation air, air filtration, and accoustic noise.

Attached is a copy of a study performed for the AMC Iroquois Project manager entitled "Study of Environmental Control Systems for Bell Armed Helicopter, AH-1G." This study is an example of human factors considerations.

Task 03, Environmental Control Equipment (ECE)

Environmental Control Equipment, including heaters and air conditioners, are designed to provide conditions suitable for maintaining efficiency of the operating personnel. Human factors engineering include such requirements as fresh air for ventilation, electrical safety devices, pressure actuated safety devices, noise level limitations, air distribution patterns, lifting attachments, accessibility of components, location and types of control mechanisms, location of power input connector, size, weight, etc.

2B. U. S. ARMY MATERIEL COMMAND
MUNITIONS COMMAND

Dover, New Jersey

EDGEWOOD ARSENAL

The Human Factors Branch is an element of the US Army Edgewood Arsenal, Research Laboratories, and responsible to the Director of the Research Laboratories and the Post Commander for planning and conducting the Edgewood Arsenal Human Factors program, encompassing the planning and conducting of a program of basic and applied research to produce human factors data for systems application, planning and incorporating human factors considerations in materiel designed by the development laboratories; incorporating human factors considerations in the safety and reliability evaluations and production inspections conducted by the Quality Assurance Directorate; and incorporating human factors considerations into the assessment and evaluation of materiel conducted by the Technical Support Directorate; to assure maximum effectiveness of man-machine combinations with chemical materiel in all operational environments.

WORK PROGRAM

The work of the Branch is developed in two broad areas; (1) Application and (2) Research. Application is further broken down into two main areas (1) support of items developed by Weapons Development Engineering Laboratories (WDEL) and Defense Development Engineering Laboratories (DDEL), and personnel are so assigned.

As of 13 July 1966 the Application effort is performed under the authority of EA Regulation 70-2, Human Factors Engineering. Essentially the effort is applied from conception through Engineering Service Testing (EST) for all Edgewood Arsenal equipment.

Applied Support Effort

DEFENSE ITEMS/SYSTEMS

Title	Date Started	Estimated Completion
Liquid Agency Detector	Nov 66	Cont
Man/Personnel Detector	Oct 66	Cont
Drinking and Resuscitating Devices for Protective Mask	Apr 64	
Point Sampling Alarm System, XM8	Dec 64	Cont
Multipurpose Chemical Agency Detector Kit,E56	Apr 64	Cont
Chemical Agent Identification Training Set (CAITS)	Jan 65	Cont
Communications System for M20 Oxygen Breathing Apparatus (OBA)	May 67	Cont
M17 Protective Mask Product Improvement Tests	Jul 66	Cont
Dexterity Evaluation of Protective Gloves	Aug 66	Cont
Glare Attenuation for M17 Mask	Sep 66	Cont
Light-Weight Mask Development Program XM27 and XM28	Jan 67	Cont
Collective Protection for M292 Expansible Van Truck and M577 CPC	Feb 65	Cont
CB Mobile Field Shelter	Apr 66	Cont
M12 Decontamination Unit	Jul 66	Completed

WEAPONS ITEMS/SYSTEMS

Projector Adapter for M23 Mine, XM42	Dec 65	Cont
Smoke Marking Munition and Aerial Dispenser	Apr 66	Cont
Canister Cluster, Tactical CS, E158	Jul 66	Cont
Canister Cluster, Tactical CS, E159	Jul 66	Cont

Title	Date Started	Estimated Completion
Service Unit, Flame Thrower, Track Vehicle Mounted, XM45	May 67	Cont
Bouchon Fuze Modification	Apr 67	Cont
Cartridge 40mm, CS, XM651	Aug 64	Cont
105 Cartridge Tactical CS XM629	Dec 66	Cont
155 Projectile Tactical, CS XM631	Jan 67	Cont
4.2 Inch Cartridge, CS XM630	Jan 67	Cont
Mixing and Transfer Unit E49R3	Feb 64	Cont
Expendable CS Launcher, E-8	Dec 64	Cont
Projector and Smoke Grenade, XM19	Jan 66	Cont
Grenade Riot Control	Aug 66	Cont
Launcher, Hand Held 40mm, CS E24	Dec 64	Cont
Flame Thrower, E36R1	May 64	Cont
Dispenser Riot Control Hand Held	Jul 66	Cont
Chemical Operations Training System	Dec 65	Cont
Drum, 55 Gal, CS with Fuze and Burster, XM920	Mar 67	Completed
Ensure Modification of Flame Thrower M9-7	Apr 67	Cont
Evaluation of CS Systems, Agents and Related Equipment	May 67	Cont
Terrain Denial System -- "Brown Bagger"	May 67	Cont

MISCELLANEOUS

Under this category have been placed projects which are not part of either WDEL or DDEL or which are specific areas of work which are common to both and have assumed some importance over the past few years.

1. AtroPen Training Injector:

A brief human factors analysis on an atropine injector training device was performed for the Surgeon Generals Office.

2. SEA Wound Ballistics Check List:

Coordinated with USAHEL and EA Biophysics Laboratory on Questionnaires proposed to collect information on SEA casualties.

3. Review of POMM's

This Office is now included in the review of the Preliminary Operations and Maintenance Manuals. A detailed review is made on each of the manuals from the viewpoint of human factors.

4. MECO's

This Office is now participating in the Manual Equipment Check out utilizing either the POMM's or other equipment manuals.

5. Board of Inquiry

Army Board of Inquiry into Army Logistics System (Brown Board). (One person three months TDY.)

6. Feedback Questionnaire

This Office participates in the preparation and evaluation of Feedback Questionnaires (MUCOM Reg 705-28, EA Reg 705-7).

Research

The Branch performs research on human factors methodology and techniques.

1. Several aspects of Human Factors concerned with the protective mask have been subsumed under the general title of "Human Engineering Considerations for Protective Mask Design." They are:

a. Intelligibility. A standard technique for evaluating the intelligibility of voice transmission through the protective mask is being developed. A report on the laboratory effort is under review.

b. Mask skin pressures. Pressure transducers for insertion into the masks have been obtained and a method for insertion has been designed.

2. Effects of Experimentally Induced Bias on Subject Performance.

This study is an attempt to understand the problem associated with field testing of protective equipment especially those resulting from the interaction and influence of the test personnel, on subject reactions. Three groups of four subjects, two weeks for each group have been run.

FRANKFORD ARSENAL

A. CURRENT WORK PROGRAM

Task	Experimenter(s)	Date Started	Estimated Completion
Special Products Devices	E. J. McGuigan	Jul 66	Cont

This is a continuing program for which funding is provided for a variety of programs concerned with guerrilla anc ounter-guerrilla warfare and related areas. Much of the work is of a classified nature and is conducted in the general areas of ammunition, improvised munitions, flares, and specialized devices concerned with unconventional warfare.

Tracer Visibility Research Program	R. F. Kelly J. A. White	Jan 65	Cont

The goal of this program is to develop an effective tracer round, visible under daylight conditions. At the request of the Small Caliber Ammunition Laboratory, a test program outline was prepared for further research on daytime visibility of tracers which would investigate the effects of various factors including candlepower intensity, ambient illumination, background characteristics, trace duration, and color. No experimental effort was undertaken during the reporting period.

Advanced Flare and Dispensing System for Army Fixed and Rotary Wing Aircraft	E. J. McGuigan J. A. White	Jul 67	Cont

The Branch role in this program is to provide human factors support to the Frankford Arsenal Propellant Actuated Devices Group. Included in the effort is a comprehensive information retrieval program to provide data on illumination levels, design details, and other areas for all current and projected flares. Contacts will be made with Army, Navy, and Air Force Installations as well as foreign sources. Future involvement in the program will be dependent on the results of the information search and any design recommendations which may emanate from the program.

Task	Experimenter(s)	Date Started	Estimated Completion
Human Factors Study of Fuze Setting Problems	E. J. McGuigan	1962	Cont

This is a continuing program in which general concepts such as safety, ease and accuracy of setting, visual factors, and specific problems are under investigation. One design study recently completed involved an improved safety point setting for the XM548, XM558, XM564, and XM565 fuzes. The proposed design has been submitted for consideration.

Stablized Optical Tracking Device	R. F. Kelly J. A. White	Aug 65	Cont

Purpose of the program is to investigate certain visual requirements for the Device to provide input to the project engineer during the development phase. The prime area of effort during the reporting period was the investigation of contrast discrimination characteristics required for an automatic tracking device. Photometric data from the NATO DRI study was analyzed to obtain the frequency distribution of luminance and contrast between military vehicles and terrain factors as well as point-to-point contrast on vehicles.

Target Acquisition	R. F. Kelly	Jan 66	Cont

Purpose of the program is to provide human factors engineering support to project engineers which will assist them in determining optimal characteristics required for fire control optical instruments. During the reporting period a laboratory evaluation of a variable magnification (zoom lens) periscope was conducted. Future planning, dependent on the availability of funding, calls for testing of the device under field conditions.

Multi-Weapon Fire Control System	L. Gallun	Jan 67	Cont

Purpose of this program is the development of ET/ST prototypes of a multi-weapon fire control (MWFC) system for rotary winged aircraft for fire direction of select combinations of ballistic aerial weapon systems. The system will involve the integration of an analog or a digital computer, a stabilized optical sight, a LASER rangefinder, night-viewing equipment, pilot and co-pilot helmet sights, a universal fire control weapon panel, hand controls, and associated control panels. Human factors aspects of the program are monitored by this Branch through periodic visits to the contractor's plant for evaluation of the cockpit mock-up configuration and by review of progress reports.

Task	Experimenter(s)	Date Started	Estimated Completion
Main Battle Tank	R. F. Kelly	Jun 60	Cont

Purpose of this program is to provide human factors engineering support for fire control for the Main Battle Tank. The work of the Branch is primarily concerned with coordinating the Frankford Arsenal human factors effort with other agencies involved in the program. During the reporting period photometric and methorological data derived from analytic work on related projects was provided for the program.

Army Forward Looking Infrared (FLIR) Airborne Target Acquisition and Fire Control System	L. Gallun	Dec 66	Cont

This program involves the monitoring of the contractor's human factors effort. The major emphasis of this Branch is directed towards insuring the compatibility of the existing sighting and tracking equipment (XM21 sighting station) in the aircraft, with the design, location, and the operational concepts of the FLIR sub-system and the intended user population.

Radioactive Illumination of Fire Control Instruments	E. J. McGuigan	Mar 67	Cont

This program is concerned with the investigation of visibility factors involved in radioactive illumination of fire control instruments. Experimental techniques and designs will be developed for comparison studies with current lighting methods to determine optimum illumination for reticles, level vials, and other fire control instrumentation. Some preliminary work with regard to information retrieval has been accomplished but initiation of the investigative phase will depend on the availability of funding.

Consultation and Advisory Services	Staff		Cont

Human factors engineering services are provided for research, development, and production engineering activities on an on-call basis. These services include such representative areas as participation in feasibility and concept evaluations, evaluation of components and/or equipment, provision of human factors engineering data to design engineers, participation on committees for consideration of human factors in product improvement contracts, and membership on ad hoc groups for investigation of specific problems.

Task	Experimenter(s)	Date Started	Estimated Completion
Monitoring Services	Staff		Cont

This function provides for the supervision, together with the technical supervisor of the contract, of the human factors engineering portions of Frankford Arsenal Research and Development contracts. Services include the evaluation of progress and final reports, visits to contractor installations as required, and participation in other phases of procurement such as pre-award meetings or contract modification. General cognizance is maintained over research and development contracts by personal contact with project engineers and evaluation of quarterly progress reports.

PICATINNY ARSENAL HUMAN FACTORS WORK PROGRAM - 1967

Task	Experimenter(s)	Date Started	Estimated Completion
a. Pyrotechnic	M. H. Weasner J. Carlock B. Bucklin	Jan 64	Continuing

This project provides human factors support for the establishment of design parameters for illuminating and target marking systems including flares, smokes and chemiluminescent materials. An extensive literature search and a continuing series of field studies has been and will be conducted to isolate the effects of illumination, color, visual acuity, burning time, terrain features, movement and other variables upon the effectiveness of specific line items.

b. Missile System Warhead Section R&D Support	G. R. DeTogni	Jul 61	Continuing

This series of projects provides human factors support for the design and development of the warhead sections for missile systems such as SPRINT and LANCE. Specific attention is paid to total system compatibility, multiple warhead capabilities, test and handling equipment and operational and procedural manual development.

c. Nuclear Projectile and Demolition R&D Support	J. Kostakis	Jul 60	Continuing

This series of projects provides human factors support for the continual design and development of various types of nuclear projectiles and demolition devices. Emphasis is placed upon portability requirements, environmental effects on handling and tactical employment procedures.

Task	Experimenter(s)	Date Started	Estimated Completion
d. Conventional Weapon System R&D Support	J. Carlock	Jan 60	Continuing

This series of projects provides human factors support for the continuing design and development of mortar systems, land mines and hand grenades. Laboratory and field studies are designed to evaluate specific engineering designs and particular operational procedures.

e. Advanced Portability Techniques	J. Carlock	Jul 62	Continuing

This project evaluates present and projected carrying devices and techniques for Picatinny Arsenal developed weapon systems. An attempt is being made to supplement existing load carrying literature with data on very heavy (over 100 pounds) loads and on the effects of load-carrying on psychomotor performance.

f. Small Munition Camouflage	P. S. Strauss J. Carlock	Sept 66	Continuing

This project is a series of laboratory and field studies aimed at developing optimum camouflage techniques for small (less than 6" sq.) munitions. The principles of imitation, blending, decision jamming and noise introduction are being studied in relation to tactical practice and human detection capability.

g. Novel Munitions Development Support	Staff	Jul 61	Continuing

This project provides human factors support for the feasibility study and/or design of novel weapon systems and munitions. Also under study is the modification of existing munitions to serve new purposes (e.g., counter insurgency operations). Additionally, state-of-the-art surveys are maintained on advanced fields of behavioral and engineering sciences which may have potential application to the R&D work of the Arsenal.

h. Consultation Services	Staff	Jul 61	Continuing

This project provides Arsenal personnel with rapid-response human factors support for short-term problems in many areas of human engineering and industrial psychology.

Task	Experimenter(s)	Date Started	Estimated Completion
i. Industrial Psychology Services	Staff	Jan 66	Continuing

This project provides consultation services for Arsenal management in the areas of employee relations, motivation, staff development and engineering and scientific personnel problems.

2B. U. S. ARMY MATERIEL COMMAND NATICK LABORATORIES

Natick, Massachusetts

A. CURRENT WORK PROGRAM

1. Man/Environment Compatibility Engineering Research

Within the Army Human Factors Engineering program, the purpose of this task is to conduct human factors engineering research in order to define and apply scientific principles of human physical and psychological characteristics to the design of clothing, equipment, and food. Anthropometric data are collected on U.S. and foreign military populations and analyzed in order to define the characteristics of body size for use in the design, sizing, and tariffing of military clothing and personal equipment. Psychological studies and performance measurements contribute to the development of military materiel that will increase the soldier's efficiency and effect compatibility among the soldier, his equipment, and his environment.

	Title	Investigator	Initiation	Completion
a.	Conduct human factors compatibility studies in the soldier, his clothing, equipment and performance in cold and tropic environments.	J. McGinnis	1961	Continuing

Human engineering studies are conducted to investigate the compatibility of the soldier and his clothing and equipment in cold and hot environments. Military systems, equipment and tasks are studied to ascertain the requirements for protection, space, movement, dexterity, and alertness in severe environments. Determinations are made of the interrelationships between protection and performance.

Title	Investigator	Initiation	Completion
b. Anthropometric studies of U. S. and foreign military populations.	R. M. White R. L. Burse	1946	Continuing

Anthropometric data on both U. S. and foreign military populations are collected, analyzed and published in order to provide reliable information on the dimensions, proportions, ranges of variation, and frequencies of body size in such populations. The anthropometric data are applicable in the design, sizing, fitting, and tariffing of military clothing and personal equipment and in the human engineering of man-equipment systems. New anthropometric surveys of the U. S. Armed Forces were carried out in 1965-66 at the request of the Defense Supply Agency. The resulting data will make it possible to up-date and revise all body-size information on the U.S. Armed Forces. Anthropometric surveys abroad have been conducted in Turkey, Greece, Italy, Thailand, Vietnam, and Korea.

Title	Investigator	Initiation	Completion
c. Provide consultation and design guidance on human factors problems associated with new items of clothing and other materiel under development.	J. McGinnis B. Crist R. M. White R. Burse F. Isgrig H. Kiess D. Randolph	1959	Continuing

Human engineering evaluations, assistance, guidance, and compatibility studies are furnished as needed in support of all types of equipment under development by NLABS. Clothing, equipage, armor, and other personal gear are included, along with aerial delivery materials and operations, tentage, containers for food and other items, field service equipment of all kinds including items used for the preparation, delivery and serving of food, and many types of general equipment.

Title	Investigator	Initiation	Completion
d. Conduct human engineering and applied research studies of the headgear, including helmet acoustics, weight, encumbrance, and other factors affecting performance.	B. Crist J. McGinnis	1959	Continuing

Human engineering research is conducted to obtain guidance information for improvement of protective headgear, particularly for combat vehicle crewmen and aviators.

	Title	Investigator	Initiation	Completion
e.	Conduct research studies in applied experimental psychology in direct support of materiel research and development efforts.	J. McGinnis B. Crist F. Isgrig	1966	Continuing

Experimental research studies are conducted as needed to support the development of specific items or families of items of clothing or equipment. Human engineering and product development personnel meet regularly to discuss the timeliness and appropriateness of this research. At present experiments are being conducted on the effects of head supported weight on the speed and precision of head movements in order to furnish background data needed to guide the development of helmets and helmet mounted items. Work is planned in support of the development of tentage and of field kitchens and bakeries.

f.	Studies to determine attitudes and preferences of soldiers toward QM food items.	J. Sidel H. L. Jacobs L. Bartoshuk	1964	Continuing

Studies are conducted to determine techniques and methods for investigating the soldier's attitude and preference toward QM material, particularly food items. Current emphasis is placed on a program of taste panel evaluations of food items under development and/or procurement.

g.	Conduct validation studies of acceptance data and development of new measuring devices.	L. Bartoshuk J. Sidel H. L. Jacobs	1966	Continuing

This is a new task initiated last year to begin a long term applied research program evaluating food acceptance techniques, sampling procedures, and subject populations.

h.	Conduct studies of psychological and environmental stress effects on perceptual and cognitive performance.	J. Lockhart H. Kiess	1965	Continuing

Studies are conducted to determine the effects of environmental stress variables on perceptual and cognitive performance. Special

Title	Investigator	Initiation	Completion

attention is given to the interrelations between psychological and environmental stress effects on differential components of a task in order to provide a basis, ultimately, for evaluating the relative effectiveness of protective clothing, personnel selection, special training, and task modifications in reducing environmentally induced performance decrements.

i. Conduct sensorimotor studies during performance of military tasks.	H. Kiess J. Lockhart	1965	Continuing

Studies are conducted to determine the sensory and psychological responses of a military population under environmental and situational variables and the effects of such responses under the performance of military tasks.

2. Basic Research in Human Capabilities

The supporting research program is directly related to the long range problems of the Food Acceptance Laboratory, and also designed for interdisciplinary collaboration with common problems of other NLABS laboratories, including Nutrition, Food Chemistry, The Experimental Kitchen and Food Irradiation in the Food Division, and Analytical Chemistry, Insecticides and Rodenticides, and Entomology in the Pioneering Research Laboratory.

a. Basic Investigations of Human Psycholphysics	L. Bartoshuk	1967	Continuing

Basic research is conducted on the sensory and perceptual capacity of human subjects, with special emphasis on problems of scaling and measurement, sensory adaptation and analysis of flavor by integration of taste and olfaction.

b. Basic investigations of Sensory Psychophysiology.	L. Bartoshuk	1967	Continuing

Basic research is conducted on problems of information transfer in taste and olfaction, using direct electrophysiological techniques to supplement the psychophysical approach outlined above. Special emphasis will be on initial receptor-site stimulation, on the patterning of receptor-fiber systems and the problem of sensory coding.

c. Basic investigations of Appetite Regulation.	H. L. Jacobs	1967	Continuing

Title	Investigator	Initiation	Completion

Basic research is conducted on the role of sensory and metabolic information supplied by the ingestion of food in the regulation of food and water intake. Special emphasis is on the role of energy balance, and environmental changes in the action of the Central Nervous System in these phenomena.

3. In-House Laboratory Independent Research

a. Changes in DFF as an indicant of physiological and psychological stress effects.	J. Lockhart	1966	Continuing

Basic research is conducted to determine the effect of thermal stress on the visual flicker-fusion threshold and to develop a differential indicant of thermal exposure induced physiological and psychological stress effects.

2B. U. S. ARMY MATERIEL COMMAND
U. S. NAVAL TRAINING DEVICE CENTER

Orlando, Florida, 32813

CURRENT WORK PROGRAM

Study, Training Device Requirements for Main Battle Tank-70

Instructor Training for Submerged Control Trainer

Study, Decision Making

NATOPS, The Study and Development of a Military Specification for Flight Manuals

Degree of Simulation vs Pilot Performance

Instinctive Firing

Study, Training Efficiency as a Function of Task Difficulty

Design Factors in Environmental Simulation

Study, Human Factors, SQS-26 Sonar Synthesis

Study, Human Factors in Training Equipment Design

Study, Team and Tactical Decision Making Applications

Study, Sensorimotor Performance

Study, Skill Retention

Study, Scoring of Team Communication

Training System Use & Effectiveness Evaluation

Motor Skills Kinesthetic Trainer

Generalized Sonar Maintenance Trainer

Study, Feedback and Cuing in Training Tasks

Study, Training Equipment and Individual Differences

Biopotential Signal Processing

Homogeneous Visual Environment

Some Effects of Stress on Learning and Performance

General Vehicular Research Tool Further Evaluation

Multi-Sensory Augmenting Feedback in Tracking Training

Study, Rhythm and Motor Skill

Study, Skill Retention

Visual and Auditory Autokinesis

2B. U. S. ARMY MATERIEL COMMAND
ARMY TEST AND EVALUATION COMMAND

Aberdeen Proving Ground, Maryland

U. S. ARMY GENERAL EQUIPMENT TEST ACTIVITY
Fort Lee, Virginia

CURRENT WORK PROGRAM

1. Test Boards, Management and Support
(Project 1E650212D618)

Task	Experimenters	Date Started	Estimated Completion
Development of Methodology for Measuring Effects of Personal Clothing and Equipment on Combat Effectiveness of Individual Soldiers (USATECOM Project #8-3-7701-01)	Mr. James C.Perkins,Jr. STEGE-ME-H, USAGETA Dr. J. William Dunlap, Dunlap & Associates, Inc. Darien, Connecticut	Jul 62	Dec 68

Work has been completed on the initial three-phase research project to develop procedures and facilities for field measurement of the effect of experimental clothing and personal equipment on the combat effectiveness of individual infantrymen. A survey of experienced combat infantrymen provided a rankded list of the physical tasks performed in combat. Performance measures were developed and evaluated for the ten most important tasks. Field facilities have been conducted to permit a realistic evaluation of the effect of clothing and equipment on the soldier's performance in these tasks using an automated data collection and analysis system. Work is continuing to validate recently constructed performance courses and to design and install a fully automated data collection and analysis system.

Task	Experimenters	Date Started	Estimated Completion
Development of a Checklist and Guidebook for Human Factors Evaluation of General Equipment (USATECOM Project #9-6-0072-01/02)	Mr. James C.Perkins,Jr. STEGE-ME-H, USAGETA Dr. E. C. Weiss, Matrix Corporation Arlington, Virginia	Aug 65	May 68

A study is in progress to develop guides for evaluation of human factors considerations during engineering and service tests of general military equipment. A checklist and procedural guidebook are being developed to aid USAGETA test engineers responsible for testing specific families of equipment. The first draft of the checklist has been completed and work is underway on the guidebook. Both the checklist and guidebook will be published in a simple, concise format covering human factors evaluations of equipment falling within the responsibility of the General Equipment Test Activity.

2. Technical Progress in Testing Army Items (Project 1E650212D618)

Task	Experimenters	Date Started	Estimated Completion
Evaluation of Psychological Techniques for Selection of Observer-Recorders for Field Tests (USATECOM Project #9-5-0023-11)	Mr. James C.Perkins,Jr. Sp4 George Schweichert, STEGE-ME-H, USAGETA	Jul 64	Nov 67

A study is in progress to establish the reliability and validity of the Lowry-Lucier Reasoning Test as a special selection device for enlisted Observer-Recorders. It is hypothesized that this test, which is reported to be less influenced by level of formal education than other tests of intelligence, may aid selecting enlisted personnel who would perform satisfactorily as O/R's during engineering and service tests of military equipment.

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Preusse, John W. "Semi-Automatic Speech Intelligibility Measurements" to be published in IEEE Transactions on Audio and Electrocoustics. Presented at the 1967 IEEE International Conference on Communications, Minneapolis, Minn. ECOM

Randall, R. Bradley. Crew Compartment Temperatures: The Effects of a Solar-Heat Reflecting Paint. Tech Note 4-66, Jul 66. HEL

Sidorsky, R. C.; Houseman, J. F. Research on Generalized Skills related to Tactical Decision Making. Tech Rpt 1329-2, (U), Dec 66. NTDC

Strauss, P. S. Perceptual distortion of job activities among engineers and scientists. Perceptual Motor Skills, 1967 (in press). PA

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Thomson, Kenneth F., Ph.D. & Houff, Charles W., Lt Col, USA Retired. A Survey of European Training Devices. Tech Rpt IH-17, May 65 (U). NTDC

Vaughan, W. S., Jr., etal. Study of Functional Requirements of Training Equipment for Army Command Tactical Decision Making. Tech Rpt 1341-1, (U) Feb 66. NTDC

Waugh, John D. Minefield Marker-Light Characteristics. Tech Note 7-66, Sept 66. HEL

Weasner, M. H. Detection and Identification of Colored Smoke, Human Factors, Vol. 8, No. 5. Oct 66. PA

Weisz, John D. System Analysis: Human Factors R&D Contributions. Tech Note 6-67. Jul 67. HEL

Wilkerson, L. W.; Norman, D. A.; Matheny, E. G.; Demaree, R. G.; and Lowes, A. L. Pilot Performance, Transfer of Training and Degree of Simulation. I. Variations in Program Cycle Time and Aerodynamic Equations. Dec 65, Tech Rpt 1388-2, (U). NTDC

2B. U. S. ARMY MATERIEL COMMAND BIOGRAPHICAL DIRECTORY OF PROFESSIONAL PERSONNEL

ABRAHAM, Jeff D., Engineering Psychologist; AB 1950, Emory University. Member: Human Factors Society. Test Analysis Office, Test Directorate, USA Electronic Proving Ground, Ft. Hauachuca, Arizona. TEC

AYRES, John J. B., CPT, MSC, Experimental Psychologist; Ph.D. 1965, University of Kentucky; Animal behavior, learning theory, motivation. Member: APA. NATICK

BARNES, John A., LTC USAF(Ret), Research Psychologist (Engr); BS 1954, MA 1966, University of Arizona; mathematics, systems engineering, psychology. Member: Psi Chi. HEL

BARTOSHUK, Linda M., Research Psychologist; Psychology Group, Behavioral Sciences Div; BA 1960, Carleton College; MSc 1963, Brown University; Ph.D. 1965, Brown University; Sensory electrophysiology and psychophysics, physiological psychology. Member: AAAS; APA; EPA; New York Academy of Sciences; Sigma Xi. NATICK

BAUER, Robert W., Research Psychologist; Ph.B. 1948, Ph.D. 1953, University of Chicago; general human factors. Member: AAAS; Sigma Xi. HEL

BELL, Barbara, Psychology Aide; Food Acceptance Group, Behavioral Sciences Div; Ohio State University; Food technology, food acceptance. NATICK

BERTIN, Morton A., Head, Training Effectiveness Dept; Ph.D. 1958, University of Florida; Engineering psychology. Member: APA; Society of Engineering Psychologists; AAAS; The Psychometric Society; American Association of University Professors; Scientific Research Society of America. NTDC

BISHOP, Clayton K., Psychologist; AB 1944, Brown University; Human engineering, experimental design, statistics, learning theory; MA 1946, Yale University; Ph.D. 1954, Indiana University. Member: APA; Sigma Xi. NTDC

BLACKMER, Raymond F., Electronics Engineer; BS 1954, University of Massachusetts; Instrumentation. HEL

BLAIWES. Arthur S., Psychologist; BS 1962, Ohio State University; MA 1966, University of Kentucky; Ph.D. 1967, University of Kentucky; Human learning and motivation. NTDC

BOILEAU, Alfred B., Sp4, Mechanical Engineer; Instrumentation Group, Behavioral Sciences Div; BSME BS Math 1965, California State Polytechnic College; Instrumentation Design, Protytype Fabrication. NATICK

BONEY, William B., Psychologist; BA 1961, Furman University; Aviation Psychology. NTDC

BRAGG, Thomas S., Engineer (Human Factors); BSEE 1961, Purdue University. HEL

BRISTOW, William M. II., PFC, Mech. Engr. Asst; A&T College, Greensboro, N.C. HEL

BUCKLIN, Bruce L, Psychologist (Human Factors); BA 1965, State University of New York at Fredonia; General Psychology. Member: Alpha Psi Omega. MUCOM (PA)

BURNER, Larry R., 2LT, AGC. US Army; R&D Coordinator; BIE 1966, MS 1966, Ohio State University. HEL

BURSE, Richard L., Engineering Psychologist; Anthropology Group, Behavioral Sciences Div; BS 1958, M.I.T.; MA 1962, Harvard University; Physical Anthropology, Biomechanics, Physiological Psychology. Member: AAAS; Human Factors Society; New England Psychological Association. NATICK

BUTLER, David H., PFC, Mech. Engr. Asst; BS 1966, Case Institute of Technology, Cleveland, Ohio. HEL

BUTTRICK, Richard L., PVT, Biological Science Assistant; Food Acceptance Group, Behavioral Sciences Div; BS 1967, Psychology and Biology, Aquinas College. NATICK

CAHILL, William D., PVT, Engineering Psychology Aid; Anthropology Group, Behavioral Sciences Div; BA 1966, Psychology, Marquette University; Anthropometry, Human engineering. NATICK

CARLOCK, Jack, Psychologist (Human Factors); BA 1960, MA 1961, Rutgers University; Load-carrying. Member: Human Factors Society. MUCOM (PA)

CARRIERO, Nicholas J., Research Psychologist; BS 1951, Canisius College; Ph.D. 1964, State University of New York at Buffalo. Member: APA; Sigma Xi. HEL

CASSATT, Robert K., Engineering Technician (Aviation); Harvard University. Member: Human Factors Society. HEL

CHAIKIN, Gerald, General Engineer (Human Factors); BSME 1956, Purdue University; Integration of Human Factors Engineerng into Weapon System Development Programs. Member: American Institute of Aeronautics and Astronautics; Human Factors Society, Huntsville Chapter; Registered Professional Engineer (Alabama). MICOM

CHAILLET, Robert F., Supervisory Psychologist; Ch. Tech Specs Ofc; BA 1954, University of Miami; general human engineering; standards and specifications. HEL

CHIPSER, S. John, Electrical Engineer; BSEE 1964, Lehigh University; Integration of Human Factors into Weapon System Development Programs. Member: IEEE; Human Factors Society, Huntsville Chapter. MICOM

CHRISTIANSON, George B., PFC, Elec. Eng. Asst; BEE 1964, New York University. HEL

CONWAY, Richard E., 1LT, OrdC, US Army, Management Analyst; SBME 1964, University of California, Berkeley; MBA 1966, Harvard University; Control Systems, Human Problems. HEL

CORONA, Bernard M., Project Engineer; BFA 1961, Industrial Design, Philadelphia College of Art. Member: SAE. HEL

COSTOS, Daryl L., Research Psychologist; Acceptance Group, Behavioral Sciences Div; BA 1965, Penn State. NATICK

CRIST, Brian, Engineering Psychologist; Engineering Psychology Group, Behavioral Sciences Div; BS 1956, Purdue University; MA 1957, Boston University; Psycho-Acoustics, human engineering. Member: Acoustical Society of America; New England Psychological Association; AAAS. NATICK

CRUSE, Charles S., Chief, Engineering Research Laboratory; Maryland Institute of Mechanical Arts. Member: US Naval Institute. HEL

CUNNOLD, Susan R., Research Psychologist; Appetite Regulation Group, Behavioral Sciences Div; BS 1963, Bucknell University; MNS 1965, Cornell University; Nutritional science. Member: AIBS; Phi Sigma. NATICK

DAVIS, C. Jane, Psychologist (Engr); AB 1937, Catherine Spalding College, Louisville, Kentucky. HEL

DEAN, Bennett W., PVT, Biological Science Assistant; Experimental Psychology Group, Behavioral Sciences Div; BS 1965, University of Alabama; BS 1966, University of Alabama; Biology, Psychology. Member: AAAS. NATICK

DELANEY, Joseph P., Research Psychologist (Engr); BA 1960, Northwestern University. MUCOM (EA)

DeTOGNI, Gino R., Research Engineer (Human Factors); BS 1951, Union College; System Analysis. Member: Human Factors Society; American Ordnance Association. MUCOM (PA)

DICKINSON, Nonnie F., CWO, USA (Ret); Armament Maintenance Technician. HEL

DWYER, John J., Sp4, Electrical Engineer; Behavioral Sciences Div; BEE 1965, Villanova University; Equipment design and prototype fabrication. NATICK

ECKLES, Andrew J., III, Research Psychologist (Human Factors); BS 1950, MA 1952, University of Louisville. HEL

ELLIS, Paul H., Industrial Designer; BS 1963, Philadelphia Museum College of Art; tanks, infantry antitank weapons. HEL

EMERY, Mason C., Equipment Specialist. HEL

ERICKSON, John R., Supervisory Engineer (Human Factors); Ch, Missile Branch; BSME 1951, Case Institute of Technology. HEL

FAIR, Paul A., Supervisory Research Engineer; Certificate, Pratt Institute 1926. Member: National Society of Professional Engineers, Susquehanna Chapter. HEL

FAMIGLIETTI, Michael A., Operations Research Analyst; BA 1949, MA 1951, University of Oklahoma; airborne fire control, operations research analyses. Member: American Mathematical Association; Pi Mu Epsilon. HEL

FERRARINI, David M., PVT, Statistician; Behavioral Sciences Div; BA 1965, Brown University, Math; Statistician 1967, Pratt & Whitney Aircraft. NATICK

FISHER, Dennis F., E5, Research Psychologist; BA 1964, San Jose State; Psychology, HEL

FOSTER, Murray, Jr., Engineering Technician (Aviation); Johns Hopkins University. HEL

FRICKE, Klaus K., PFC, USA, Electrical-Electronic Engineering Assistant; AEE 1966, Ohio Technical College. Member: IEEE. HEL

GANTZ, Donald T., Sp4, USA, Mathematician; AB 1966, Fordham University. HEL

GALLUM, Louis, Mechanical Engineering Technician; Weapon Systems & Equipment. Member: Human Factors Society, Delaware Valley Chapter; Optical Society of America. MUCOM

GARINTHER, Georges R., Research Engineer; BSEE 1957, Gannon College. HEL

GARRY, Thomas A., Research Psychologist (Engr); BS 1952, Long Island University. HEL

GEBHEIM, Gerald C., Mechanical Engineering Assistant; BSME 1966, California State College; Integration of Human Factors Engineering into Weapon System Development Programs. Member: Human Factors Society, Huntsville Chapter. MICOM

GEHRINGER, Edward E., Research Psychologist; MA 1959, George Washington University. HEL

GERUNTHO, Hannibal, Mechanical Engineer; BSME 1948, Newark College of Engineering; Electronic Packaging; R&D Directorate. ECOM

GIL, Elias E., Sp4, Elec. Engr. Assistant; BSEE 1966, Texas A&M. HEL

GIORDANO, Dominick J., Inst Eng: BSEE 1961, Newark College of Engineering. HEL

GOLDEN, Michael G., Engineering Technician (Human Factors); BS 1963, Industrial Design, Philadelphia College of Art; MA 1964, Industrial Design, Stanford University. HEL

GORDON, Thomas P., Research Psychologist (Physio & Exp); BS 1962, University of Scranton; MS 1965, University of Delaware. Member: Psi Chi; Sigma Xi. HEL

GRABOWSKI, Simon J., Mechanical Engineer (Human Factors); BS 1954, Detroit Institute of Technology. ATAC

GRIFFITH, Paul E., Supervisory Electronic Engineer; BA 1929, Carleton College, Communication Sciences. Member: Acoustical Society of America, Senior Member; IEEE; Sigma Xi. ECOM

GSCHWIND, Robert T., Research Engineer (Human Factors); BS 1956, Lehigh University; mechanical engineering. HEL

GURMAN, Bernard S., Electronic Engineer; BSEE 1958, Northeastern University; aircraft instrumentation. Displays/Controls-Human Factors. Member: Society for Information Displays; IEEE (G-HFE). ECOM

HARTOS, Andrew S., Electronic Engineer; BSEE 1950, Oklahoma State University; airborne electronics. ECOM

HEAD, Thomas W., PFC, US Army, Mathematician; BA 1966, Southern Illinois University. HEL

HEMBREE, Howard W., Technical Director; Ph.D. 1952, University of Maryland; Psychology. Member: APA; Virginia Psychological Association; Society of Engineering Psychologists; Human Factors Society; AAAS. GETA

HENNESSY, John R., Research Psychologist (Engr); Ph.D. 1964, New York University; bionics, learning. Member: Human Factors Society. ECOM

HODGE, David C., Research Psychologist (Engr. Psychology); BA 1953, Hardin-Simmons University; MA 1959, Texas Technological College; Ph.D. 1963, University of Rochester; vision, psycho-acoustics. Member: APA (Div. 21); Sigma Xi; Human Factors Society; AAAS: EPA; Acoustical Society of America. HEL

HOLLAND, Howard H., Research Engineer (Human Factors); BSME 1942, BSAE 1948, Virginia Polytechnic Institute. HEL

HORLEY, Gary L., Industrial Designer (Human Factors); BFA 1956, Philadelphia Museum College of Art. HEL

HOUFF, Charles W., LTC USAR (Ret), Training Specialist (Human Factors); University of Virginia and University of Maryland. MUCOM (EA)

HOWE, Wesley K., E4, Research Psychologist; BA 1964, Windham College; Psychology. HEL

HUDGENS, Gerald A., Research Psychologist; BA 1960, Knox College; MA 1961, University of Denver; Ph.D. 1965, Purdue. HEL

ISGRIG, Frederick A., CPT, MSC, Experimental Psychologist; Engineering Psychology Group, Behavioral Sciences Div; Ph.D. 1964, University of Arkansas; experimental design, statistics, comparative psychology. Member: Sigma Xi. NATICK

JACKSON, Samuel E., Jr., Research Psychologist (Engr); BS 1956, University of Louisville; MA 1965, University of Louisville. Member: Human Factors Society; AAAS. MUCOM (EA)

JACOBS, Harry L., Deputy Director for Behavioral Sciences; Pioneering Research Laboratory and Chief, Psychology Group; Ph.D. 1955, Cornell University; Physiological Psychology, Sensory and Regulatory processes in food intake. Fellow: APA. Member: American Physiological Society; Psychonomic Society; Animal Behavior Society; Sigma Xi; Society for Psychophysiological Research; Society for Experimental Medicine; AAAS; AAUP; AIBS. NATICK

JOHNSON, William B., CWO4, US Army, Armament Maintenance Technician; University of North Carolina and University of Maryland. Member: American Ordnance Association. HEL

JOHNSON, William J., Research Psychologist; BA 1963, LaSalle College. HEL

JOHNSTON, Marion P., Sp4, US Army, Mechanical Engineering; North Carolina State University. HEL

JONES, Emily J., Psychology Technician; BA 1962, University of Nevada. HEL

JORDAN, Stephen, Psychologist; BA 1957, Brooklyn College; MA 1959, The New School for Social Research; Ph.D. 1967, The New School for Social Research; Sensory Processes, Motor Skills, Simulation. Member: APA (Pending). NTDC

JUSTER, Ronald S., Sp4, Biomedical Engineer; Instrumentation Group, Behavioral Sciences Div; AASEE, BSBME 1965, New York Institute of Technology; Instrument design, prototype fabrication. NATICK

KALEN, Sylvester E., COW4, US Army (Ret), Engineering Technician (Human Factors). HEL

KAMLET, Arthur S., 1LT, MSC, Research Psychologist; BSEE 1961, Worcester Polytechnic Institute; MSE 1963, University of Michigan; MA 1965, University of Michigan; Ph.D. 1967, University of Michigan. HEL

KARSH, Robert, Research Psychologist; BA 1957, Brooklyn College; General Human Factors. HEL

KATCHMAR, Leon T., Chief, Systems Research Laboratory; Ph.D. 1954, University of Maryland. Member: APA; EPA; International Ergonomics Association; EIA M5.7 Committee (Mil Con); NRC Committee on Vision. HEL

KELLER, Andrew D., Sp4; BA, Mankato State College. Member: Acoustical Society of America. GETA

KELLY, Roger F., Engineering Technician; BS 1933, Illinois State University; Vision, shock and vibration, audition. Member: Human Factors Society, Delaware Valley Chapter; Optical Society of America. MUCOM

KEYSER, James M. B., Anthropologist; BA 1954, Haverford College; MA 1964, Harvard University. Member: Philadelphia Anthropological Society. HEL

KIESS, Harold O., CPT, MSC, Experimental Psychologist; Behavioral Sciences Div; Ph.D. 1967, University of Illinois; Human performance, engineering psychology, experimental design. Member: MPA; Sigma Xi. NATICK

KLETT, Shirley L., Research Psychologist (Physio. & Exp.); BS 1950 MS 1952, Washington State University; Ph.D. 1957, University of Washington; general human engineering, information retrieval. Member: APA; Maryland Psychological Association. HEL

KOSTAKIS, John, Psychologist (Human Factors); BA 1961, MS, CCNY; Environmental Stress. Member: Human Factors Society. MUCOM (PA)

KRAMER, Richard R., Research Engineer (Human Factors); BA 1956, Williams College. HEL

KURTZ, Albert K., Psychologist; AB 1926, Stanford; Ph.D. 1930, Ohio State; Statistical Methods; Aptitude Tests; Industrial Psychology. Member: Sigma Xi; AAAS; APA, Member, Program Committee; Psychometric Society, One of founders, Treasurer, Secretary; Council for Basic Education; American Educational Research Association; American Association of University Professors; Florida Psychological Association. NTDC

KURTZ, Gary L., Engineer (Human Factors); BS 1959, Pennsylvania State University. HEL

LAMBERT, David, P., Electrical Engineering Assistant; Northrop Institute of Technology; Integration of Human Factors Engineering into Weapon System Development Programs. Member: Human Factors Society, Huntsville Chapter. MICOM

LEVINE, Murray D., Research Psychologist (Phy. & Exp.); Ph.D. 1963, Pennsylvania State University; Psychology. Member: APA, EPA. HEL

LEWIS, John W., Supervisory Psychologist (Engr); BA 1948, George Washington University; Human Factors Engr. Member: Human Factors Society; APA; Society for Applied Anthropology. MUCOM (EA)

LINCE, Donald L., Engineer (Human Factors); BSEE 1950, Worchester University; Poly Tech Institute. Member IEEE. HEL

LINDER, Arno, Electronic Engineer; BA 1948, Brooklyn College; Aircraft Instrumentation, Displays/Controls-Human Factors. Member: IEEE; American Physical Society. ECOM

LOCKHART, John M., Research Psychologist; Psychology Group, Behavioral Sciences Div; MS 1961, University of Wisconsin; Effects of environmental stress on performance, Human Vision, Motivation. Member: RESA; AAAS; EPA, APA. NATICK

LUKAS, Jeffrey H., Research Psychologist (Human Factors); BA 1967, Syracuse University. HEL

MACNEIL, Donald A., CPT, MSC, Research Psychologist; BA 1962, Lafayette College; MA 1964, Bucknell University; MA 1965, Princeton; Ph.D. 1966, Princeton. Member: EPA. HEL

MARCHINA, Robert M., Sp4, Psychology Laboratory Assistant; Acceptance Group, Behavioral Sciences Div; Indiana University, St. Joseph College; Food acceptance, olfaction. NATICK

MATANZO, Francisco, Jr., 1LT, MSC, Research Psychologist; BS 1964, Ohio State University; MA 1965, Ohio State University. MUCOM (EA)

MAZURCZAK, Joseph, Electrical Engineer; BEE 1963, CCNY. HEL

McCAIN, Claude N., Jr., R.P.E., Supervisory Research Engineer; Chief, Supporting Research Laboratory; BSCE 1959, University of South Carolina; General human factors: NSPE; MSPE. HEL

McCOMMONS, R. Bruce, Research Psychologist (Engr); BA 1963, Washington College. HEL

McGINNIS, John M., Research Psychologist (Exp. & Phy.); Engineering Psychology Group, Behavioral Sciences Div; Ph.D. 1929, Yale University; Human factors in system design, engineering psychology, load carrying attitude measurement. Fellow: APA; Life Member: Mid-western Psychological Association; Fellow: Massachusetts Psychological Association; Member: Psychonomics Society, New England Psychological Association; Fellow: AAAS; Diplomate in Industrial Psychology. NATICK

McGUIGAN, Eugene J., Supervisory Psychologist; MA 1962, Temple University; Vision, audition, systems analysis. Member: APA; Human Factors Society; EPA; Research Society of America; Optical Society of America. MUCOM

McKENZIE, David M., 2LT, AGC, US Army, Criminology; BA 1964, Ohio University; MA (Pending), University of Maryland. Member: Academy of Political & Social Sciences; American Sociological Association. HEL

MEDARIS, John B., Jr., MAJ, US Army, R&D Coordinator; BS 1959, US Military Academy; MS 1965, New Mexico State University; Mechanical Engineering. HEL

MICHELI, Gene S., Acting Head, Training Technology Department; BA 1949, New York University; MA 1952, Fordham University; Ph.D. 1966, New York University; Training Research; Human Engineering; Personnel Research. Member: APA, Division of Industrial Psychology; Society of Engineering Psychologists; EPA; Human Factors Society; Metropolitan Chapter of Human Factors Society; AAAS; Society for Information Display; Listed in American Men of Science. NTDC

MILES, John L., Jr., Research Psychologist (Engr); BS 1960, Washington & Lee University; MS 1967, University of Idaho; Psychology. HEL

MILLER, Knox E., Psychologist; BS 1951, Florida State University; MS 1953, Florida State University; Ph.D. 1961, Florida State University; Visual perception and control/display dynamics in training devices related to aircraft, radar and tactical data systems. Member: Sigma Xi. NTDC

MONTY, Richard A., Research Psychologist; BA 1956, Boston University; MA 1957, Columbia University; Ph.D. 1961, University of Rochester. Member: Sigma Xi; Human Factors Society; APA; EPA; The Psychonomic Society. HEL

MORELAND, Stephen, Engineer (Human Factors); BS 1956, University of Illinois; Industrial Education. Member: Human Factors Society; Iota Lambda Sigma Nu Chapter of the National Professional Industrial Education Fraternity; American Helicopter Society. HEL

MORENO, Frank J., Operations Research Analyst;BS 1961, University of Pittsburg; math modeling, systems engineering. Member: Society for Industrial and Applied Mathematics. HEL

MULLEN, William C., Engineering Technician; Loyola College. HEL

NAIR, Ward M., Mathematician; Weapon Systems Analyses; BA 1961, MS 1964, University of Wyoming. HEL

NEWCOMB, Fred N., Engineer (Human Factors); University of Maryland. HEL

NICHOLS, Thomas L., CPT, MSC, Experimental Psychologist; Behavioral Sciences Div; Ph.D. 1966, University of Texas; Psychoacoustics, Data acquisition and processing. Member: Assoc. Member of Acoustical Society of America; AAAS. NATICK

NIELSEN, John J., Sp5, US Army, Mechanical Engineering Assistant; BSME 1964, California State Polytechnic College; Mechanical Design. HEL

OATMAN, Lynn C., Research Psychologist (Engr); BA 1958, University of Nebraska; MA 1961, University of Nebraska; Vision. Member: APA; Psi Chi; AAAS. HEL

OLSON, Lawrence E., PVT, Biological Science Assistant; Food Acceptance Group, Behavioral Sciences Div; BS 1964, Central Missouri State College; Biology; MS 1967, Fort Hays Kansas State College; Zoology. NATICK

PERKINS, James C., Jr., Chief, Human Factors Division; MA 1965, Richmond Professional Institute; Psychology. Associate Member: APA; Virginia Psychological Association. Member: Human Factors Society; AAAS. GETA

PETTIT, George D., Electrical Engineer (Instrumentation); BSEE 1949, North Carolina A & T. HEL

PHELPS, Russell M., CPT, R&D Coordinator; BS 1961, USMA. HEL

POWELL, Thomas J., E4, Per Psych Sp; BA 1965, Lycoming College, Williamsport, Pennsylvania. HEL

PRICE, George R., Research Psychologist (Phy & Exp); AB 1960, University of Delaware; Ph.D. 1963, Princeton University. Member: APA; Sigma Xi. HEL

RAAEN, John C., Jr., COL, CO, USAHEL; BS 1943, USMA; 1943, Engr School, Ft. Belvoir, Va; 1949, US Navy Post Grad School, Annapolis; MA 1951, Johns Hopkins University; C&CSG 1955, Ft. Leavenworth, Kansas; 1960, Ind. College of Armed Forces. HEL

RAKOWSKI, John R., Research Psychologist (Engr Psy); BA 1951, Western Reserve University; M. Ed. 1961, Rutgers University; Psychometrics, Education. Member: IEEE. ECOM

RANDALL, R. Bradley, Engineering Technician; BA 1959, Alma College. HEL

RANDOLPH, David I., CPT, MSC. Research Psychologist; Radiation Physics Group, Pioneering Research Laboratory; Ph.D. 1965, University of Massachusetts; Flash Blindness; Neurophysiology of vision. Member: Optical Society of America; AAAS. NATICK

RAPPOPORT, Emilie L., Research Psychologist (Engr); BA 1962, Wittenberg University; MA 1964, Ohio State University; Integration of Human Factors Engineering into Weapon System Development Programs. Member: APA; Human Factors Society, Huntsville Chapter. MICOM

RASKI, Ronald J., PFC, Elec. Engr. Assistant; BSEE 1965, University of Washington. HEL

REGAN, James J., Chief Psychologist; Ph.B. 1948, University of Detroit; MA 1951, Fordham University; Ph.D. 1957, Fordham University; Training Research and Human Factors. Member: APA; AAAS; New York State Psychological Association; EPA; Senior Member, IEEE; Ergonomics Society; Human Factors Society; Sigma Xi. NTDC

ROBERTSON, Stanley H., General Engineer (Human Factors); BSME, 1932, University of Kentucky; KSPE, NSPE; Tech. & Rsch Support Dept. MOCOM

SANTANELLI, Anthony, Research Psychologist; AB 1950, MA 1954, The Catholic University; Image Interpretation; Displays; Programmed Learning. ECOM

SCHAEFER, James A., Sp4, US Army, Mathematical & Statistical Assistant; BS 1965, Marietta College (math); University of Illinois. HEL

SCHWEICKERT, George A., Jr., Sp4, Psychological Research Specialist; MA 1965, Columbia University; Psychology. Associate Member: American Personnel and Guidance Association. GETA

SIDEL, Joel L., Acting Head; Food Acceptance Group, Behavioral Sciences Div; BA 1963, Clark University; MA 1967, Northeastern University; Experimental design, statistics, data processing. NATICK

SLATTERY, John J., Jr., Engineer (Human Factors); BS University of Notre Dame. Member: American Institute of Aeronautics & Astronautics; IEEE. HEL

SMITH, Dorothy G., Dietician; Food Acceptance Group, Behavioral Sciences Div; BS University of Washington; Food Technology, hospital dietetics, home economics, nutrition. NATICK

SPELLMAN, Edsel A., Engineer (Human Factors); BSME 1953, Indiana Technical College. HEL

STEPHENS, John A., Chief, Aviation Branch; Systems Research Laboratory; BFA 1951, Rhode Island School of Design. HEL

STEPHENS, Patricia K., Psychologist; BA 1963, C. W. Post College; MA 1965, Fordham University; Human Engineering, Training, Experimental Design. Member: Human Factors Society. NTDC

STOWELL, Harry R., MAJ. USAF (Res), Engineering Technician; San Diego Junior College; Xavier University; Electro/Hydraulics, air-to-ground and air-to-air recovery. HEL

STRAUSS, Paul S., Supervisory Psychologist; BA 1955, Hunter College; MA 1957, Ph.D. 1966, New York University; Industrial Psychology. Member: APA; Human Factors Society. MUCOM (PA)

SULLIVAN, Joseph H., MAJ, OrdC; Applied Mathematics; BS 1959, USMA; MSE 1963, Purdue University. HEL

SUMMERS, Earl P., PVT E-2, Biologist (Human Factors); Behavioral Sciences Div; BS 1966, Claflin College; Biology. Member: Omega Psi Phi. NATICK

THOMSON, Kenneth F., Staff Psychologist; BA 1939, Wayne State University; MA 1942, Ohio State University; Ph.D. 1948, Ohio State University; Human Engineering, Training, Psychometrics. Member: APA; AAAS; Sigma Xi. NTDC

TORRE, James P., Research Psychologist (Physiological, Experimental & Engineering); Chief, Weapons Branch; BA 1954, Adelphia College. HEL

TUCKER, David J., IV, PFC, US Army, Mechanical Engineer; BA 1964, Erskine College; Aircraft instrumentation, equipment improvement. HEL

VANDENBELT, David J., PFC, Biological Science Assistant; Behavioral Sciences Div; BA 1966, Kalamazoo College; Physiology, animal behavior. Member: Ecological Society of America. NATICK

VOSS, Harold A., Acting Head, Psychological Applications Dept; BA 1935, Fordham; MA 1937, Fordham; Human Factors. NTDC

WAUGH, John D., Human Factors Engineer; BSME 1960, Univeristy of Buffalo. HEL

WEASNER, M. Harold, Psychologist (Human Factors); MA 1957, University of Virginia; Experimental Psychology. Member: APA; Human Factors Society. MUCOM (PA)

WEISZ, John D., Technical Director, USAHEL; Ph.D. 195[illegible], University of Nebraska. Member: Army Human Factors Engineering Committee; National Academy of Sciences; Committee on Hearing & Bio-Acoustics (also Vision); The Army Research Council. HEL

WHITE, James A., Sp4, Psychologist; BA 1966, Virginia Union University; Human factors engineering. MUCOM

WHITE, Robert M., Head, Anthropology Group; Behavioral Sciences Div; BS 1939 (Biology), Haverford College; Graduate work in anthropology, 1939-42; 1946-48, Harvard University; Physical anthropology, anthropometry, human engineering. Member: Human Factors Soceity (Past President, New England Chapter); American Association of Physical Anthropologists; Fellow: American Anthropological Association; Associate: Current Anthropology; Research Society of America. NATICK

WIBOM, Eric G., Supervisory General Engineer; ME 1918, Stevens Institute of Technology; Professional Engineer, New Jersey; Communication-Electronics Member: Human Factors Society. ECOM

WICKSTEAD, James C., Sp4, Mechanical Engr Assistant; BID 1963, Pratt Institute. Member: Industrial Design Institute. HEL

WILSON, Donald R., Sp4, US Army; BS 1966, Louisiana State University (Physics). HEL

WOKOUN, F. William, Jr., Research Psychologist; Ph.D. 1959, University of Nebraska. Committee Member: SAE. HEL

WOOD, Alan W., Physical Scientist; BS 1959, Monmouth College; Avionics. Member: Human Factors Society. ECOM

WOODWARD, Arthur A., Jr., Research Physiologist; AB 1938, Oberlin College (Zoology); MA 1940, Wesleyan College (Biology); Ph.D. 1947, University of Pennsylvania (Zoology). Member: IES; Sigma Xi; Corp. of Marine Biological Lab. HEL

ZUBAL, Orest, Sp4, US Army, Mechanical Engineering Assistant; BAAE 1966, The Ohio State University. HEL

ZWAGGERMAN, Glen L., Sp4, US Army, Mechanical Engineer; BSME 1966, Iowa State University. HEL

2C. U. S. MEDICAL RESEARCH AND DEVELOPMENT COMMAND OFFICE OF THE SURGEON GENERAL

Washington, D.C. 20310

SELECTED ASPECTS OF CURRENT WORK PROGRAM

1. Although the US Army Medical Research and Development Command does not have a primary "human factors" mission, as such, virtually all of the Medical Research and Development program bears directly on problems of human effectiveness and, hence, in the broadest sense, may be thought of as human-factors-related. Fiscal support for this research program is provided by the Life Sciences Division of the US Army Research Office.

2. AR 705-5 gives the Surgeon General sole responsibility for conducting research and development within the area of "psychophysiological aspects of sensation perception and motor coordination." Selected aspects of this research program are as follows:

	WORK UNIT	INVESTIGATORS	DATE STARTED	CURRENT STATUS
a.	Psychophysics of Visual Perception	G.S. Harker, Ph.D. I. Behar, Ph.D. USAMRL, Ft Knox	Mar 56	Continuing

The purpose of this work unit is to understand the binocular visual function as it relates to visual performance in stereoscopic vision, binocular depth perception, form discrimination, and to the underlying neural, muscular, and CNS components, to be used in the development and employment of military vision devices.

b.	Psychophysiology of Vision	Adams, C.K., CPT, MSC Harker, G.S., Ph.D. Cronholm, J.M. Hatfield, J.L., MAJ, MSC	Jul 63	Continuing

The purpose of this work unit is to classify and quantify defective color vision in US Army personnel, and to investigate the anatomical and physiological basis of defective color vision through work with infrahuman primates.

c.	Audition and Auditory Perception	Loeb, M.,Ph.D. Fletcher, J.L., LTC, MSC Hatfield, J.L., MAJ, MSC Kohfeld, D.L., CPT, MSC Cronholm, J. N. USAMRL, Ft Knox	Jan 55	Continuing

The purpose of this research is to investigate psychophysiological correlates of acoustic stimulation--e.g., middle ear and inner ear action and psychophysical discrimination as well as associated changes in central neural actions.

d.	Traumatic Origins of Hearing Loss	Fletcher,J.L.,LTC,MSC Loeb, M., Ph.D. Behar, I., Ph.D. USAMRL, Ft Knox	Jan 55	Continuing

The purpose of this work unit is to determine and study the relations between noise exposure, and hearing loss, and to predict susceptibility to noise induced hearing loss.

e.	Disorientation and Performance	Brown, J. H.,Ph.D. Wolfe, J.W., Ph.D. USAMRL, Ft Knox	Jul 65	Continuing

The purpose of this work unit is a long-range effort to provide fundamental information required to anticipate future problems and to solve contemporary problems stemming from spatial disorientation.

f.	Vestibular Function and Disorientation	Wolfe, J.W., Ph.D. Brown, J.H., Ph.D. Marshall, J.E., CPT, MSC USAMRL, Ft Knox	Jul 54	Continuing

The purpose of this work unit is the thorough understanding of vestibular biophysics and physiology, such that appropriate personnel selection, training and equipment measures may be recommended prior to exposure to man to unusual acceleration environments.

g.	Measurement, Composition and Stability of Complex Skills	Herbert, M.J.,Ph.D. Harris, M.R., CPT, MSC Hatfield, J.L., MAJ, MSC USAMRL, Ft Knox	Jun 56	Continuing

The purpose of this work unit is to develop procedures for measuring the components of complex skills; to identify basic abilities, both general and specific, to a variety of skills; to observe revealed ability patterns under conditions of practice and stress, to test the regression hypothesis in performance decrement.

h.	Biomechanical Aspects of Performance Decrement	L.S. Caldwell, Ph.D. A.J. Lloyd, CPT, MSC G.S. Harker, Ph.D. D.L. Kohfeld, CPT,MSC USAMRL, Ft Knox	Jun 56	Continuing

The purpose of this work unit is to develop techniques to measure human strength and endurance in heavy work situations, to study factors in the work situation which influence efficiency, to derive general principles which would help in understanding and predicting work efficiency and to study the contribution of personality factors to individual differences in susceptibility to performance decrement.

i. Specific contract support in this program includes:

(1) J.R. Binford and J.B. Thurmond, University of Louisville: Vigilance--Factors influencing detection and monitoring performance (MD-2197). These investigators are attemping to describe the task variables underlying watchkeeping, vigilance, and signal detection performances; to delineate procedures and methods of improving control over level of watchkeeping performance and vigilance; and to modify and extend existing theory of sensory processes and detection theory to the vigilance situation.

(2) J. L. McGrath, Human Factors Research, Inc.: Temporal Orientation and Task Performance (MD 2743). The purpose of this research program is to determine how temporal orientation influences human performance, and to determine how temporal orientation may be controlled to enhance performance.

(3) J. S. Warm, University of Louisville: Stimulus Factors in Human Timing Behavior (MD 2918). This research is studying temporal perception with the use of tasks requiring timing factors such as perceived signal duration, watchkeeping performance, and reaction time to critical signals.

(4) G. R. Wendt, University of Rochester: Adaptation of Bodily Rotation (MD 2464). This research is aiming at synthesis and clarification of psychological and neural mechanisms of the arousal-activation-habituation-sleep systems by correlative studies of motivational and emotional states, habituation to rotation, sleep and their neural controls.

(5) B. K. Lester, University of Oklahoma Medical School: Performance during drowsy states and sleep (MD 2758). This project studies sleep, sleep loss and behavior by analyzing performance before, during and after acute and partial sleep deprivation.

(6) E. Hartmann, Boston State Hospital: Sleep and dream research (G-9237). This series of studies is investigating what proportions of sleep, in what quantities, are necessary for optimal human performance, and is exploring methods to produce maximally beneficial sleep in the least possible time.

(7) R. Smith, University of Louisville: Effects of drugs on sensorimotor processes and mentation (MD 2688). Drugs are studied to assess their effects on intellectual functioning, auditory functions and muscular endurance/fatigue.

(8) L. Kaufman, Albert Einstein Medical School: Suppression and fusion in stereopsis (MD 2654). This research is elucidating the operations underlying stereoscopic combination on both physiological and psychological levels.

3. The mission of the US ARMY AEROMEDICAL RESEARCH UNIT, at Fort Rucker, Alabama, is to conduct timely aviation medical research which will be relevant to Army Aviation and airborne physical performance standards, medical aspects of retention and selection, training operations and equipment requirements. Liaison is maintained with Army, Navy, Air Force, Federal Aviation Agency and other federal and civilian institutions concerning aviation and airborne activities, and collaborative studies are conducted whenever possible to avoid duplication of effort. Current USAARU work program includes:

Development of a qualitative measure of color vision--LTC R. W. Bailey and MAJ J. K. Crosby.

Study of dark adaptation criteria inherent in Army aviation--LTC R. W. Bailey.

Visibility criteria associated with Army aviation--MAJ J. K. Crosby.

Refractory changes as a function of age--LTC R. W. Bailey and MAJ J. K. Crosby.

Determination of optimal methods for aeromedical evacuation--LTC W. P. Schane and MAJ M. S. Nix, Jr.

Aeromedical psychology--CPT J. A. Bynum.

EKG monitoring of pilots in flight--LTC W. P. Schane.

EKG monitoring of parachutists--LTC W. P. Schane.

Human response to military parachuting on drop zones above 5000 feet MSL--LTC W. P. Schane.

Cochlear dynamics--R. T. Camp, Jr.

Hearing protective devices evaluation--R. T. Camp, Jr.

Effects of distortion in military communication system--R.T. Camp, Jr.

Acoustical environment of Army aviation personnel--R. T. Camp, Jr.

Army aviation audiometry program--R. T. Camp, Jr.

Energy expenditure in flying army aircraft--AMJ D. E. Littell and LTC R. Joy.

Physical exam and sick call analysis--MAJ D. E. Littell.

Vestibular stimulation and visual effects in Army aircraft--H. W. Huffman, Dr. F. Guedry (NAMI), and C. W. Hixson (NAMI).

Neural mechanisms of light and dark adaptation--CPT Roy H. Steinberg.

Atmospheric environment in Army aircraft--CPT G. L. Hedy, and LTC W. P. Schane.

Creatinine clearance in pilots while flying Army aircraft--CPT M. S. Nix.

Urinary hormone level in free-fall parachuting--LTC W. P. Schane and J. K. Colshour.

Aircrew equipment design for human safety--CDR C. L. Ewing (USN, NAMI) and LT D. J. Thomas (USN, NAMI).

Lift generated by the human body in free-fall--LTC W. P. Schane.

4. Other USAMRDC research programs of especial human factors interest:

	WORK UNIT	INVESTIGATORS	DATE STARTED	CURRENT STATUS
a.	Military Performance	Dusek, E.R.,Ph.d. Kobrick, J.L., Ph.D. USARIEM, Natick	Jan 64	Continuing

This research is producing information on the effects of extreme climactic stresses on important aspects of a soldier's performance and on methods and techniques for preventing decrements under such stresses. This research involved investigations of how heat, cold, wind, moisture and anoxia, independently and in combination, affect a soldier's perceptual, intellectual, psychomotor, gross motor and emotional responses.

b.	Environmental Psychophysiology	Dusek, E.R., Ph.D. Barofsky, I., Ph.D. Fine, B. J., Ph.D. USARIEM, Natick, Mass.	Jan 64	Continuing

This research provides information on the basic mechanisms involved in psycholphysiological responses in organisms experiencing extreme climacteric stresses. Research is conducted primarily on animals to determine the peripheral and control processes involved in their behavior under extreme thermal stress. Drugs will be used in attempts to reverse the effects of climactic stresses. The acquisition of responses in stimuli under conditions of climactic stress will be studied in order to determine the effects of such stresses on perception and learning.

c.	High Altitude Bioenergetics	Consolazio, C.F. Matousb, L. O. Krzywicki, H. J.	Jul 66	Continuing

This research is attempting to determine the detrimental effects of high terrestrial elevation (10 - 18,000 ft.) in human performance in order to assess the limitations on military operations at these elevations, to evaluate acclimatization to altitudes, and to minimize these effects through nutrition, selection, conditioning, drugs or other means.

d.	Physiological and Psychological Aspects of Performance at Altitudes	Evans, W.O., MAJ Carson, R., CPT USAMRNL, FGH, Denver	Jul 66	Continuing

Research on this work unit will be directed towards a description of the deterioration of different types of human capacities to perform physical, psychomotor, and mental tasks which are produced by a rapid transition from low terrestrial elevation to those ranging from 10 - 18,000 feet. In addition, correlations between behavioral and physiological changes will be determined in order to suggest ameliorative measures to reduce performance deterioration.

e.	Studies of Muscular Activities of Cadets at USMA	El Beheri, Sami, MAJ, MSC USAMRU, USAN, USMA	Jul 66	Continuing

This research is investigating the physiological aspects of some physical phenomena which are associated with training at USMA, such as brace palsy, decrement in physical performance, evidence and degree of muscle fatigue, and changes in body weight.

f.	Effects of Fatigue and Variations in Sleep Patterns Upon New Cadet Performances	Lauterbach, C.G., LTC, MSC USAMRU, USAH, USMA	May 65	Completed

This research has attempted to trace sleep patterns of new cadets and relate them to broad aspects of USMA performance (academic and physical education grades), to attitudinal and personality test variables, and to specific measures of intellectual and physical functioning.

g.	Relation of Certain Psychological Factors to Adaption at West Point	Lauterbach, C.G., LTC, MSC Vielhaber, D.P., MAJ, MSC USAMRU, USAH, USMA	Mar 63	Continuing

This study is attempting to specify and compare the initial motivation expressed by new cadets to attrition and subsequent cadet performance. It will also compare personality and leadership traits of USMA cadets with those of OCS candidates.

h.	Follow-up Study of Cadet Attrition	Dienal, R.M., LTC, MSC Lauterbach, C.G., LTC, MSC USAMRU, USAH, USMA	Jun 62	Continuing

This is a followup study concerning the adjustment and performance of cadets who left the Academy during their Fourth Class year, 1952-53, 1957-58 and 1959-60.

i.	Behavioral Effects of Infectious Diseases	Alluisi, E.A., Ph.D. Univ. of Louisville (MD-2567)	Jul 66	Continuing

This research is attempting to design, construct, and standardize test equipment to measure man's performance on a variety of tasks, and is utilizing this equipment in quantifying the nature and pattern of performance decrements associated with infectious diseases.

j.	Social and Preventive Psychiatry	Morgan, D.W., MAJ,MC Wiest, B. J., LTC, MSC Maillet, E.L., LTC, MSC Morrill, R. G., CPT,MC WRAIR		Continuing

The purpose of this research is to investigate the sociocultural and organizational factors which influence military adjustment and performance.

k.	Measurement of Performance and Decrement Under Stress	Frazier, T.,Ph.D. Sorensen, J.C., CPT, MSC Bitetto, V.E. CPT, MSC Braine, M.D.S., Ph.D. WRAIR	Jul 61	Continuing

This research focuses on the behavioral analysis of human performance and the decremental effects of stress. Considerable emphasis is given to learning and memory processes, language and communication, and decision-making processes.

2C. U. S. ARMY MEDICAL RESEARCH AND DEVELOPMENT COMMAND BIBLIOGRAPHY OF PUBLICATIONS SINCE LAST CONFERENCE REPORT

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2D. U.S. ARMY BEHAVIORAL SCIENCE RESEARCH LABORATORY

Washington, D.C. 20315

MISSION AND SCOPE

The U. S. Army Behavioral Science Research Laboratory, a Class II activity under the jurisdiction of the Chief of Research and Development, undertakes a comprehensive program of research as approved by the Chief of Research and Development in broad areas of military research selection, human performance experimentation, manned systems research, and operations research. The research is conducted in and for the Department of the Army to meet objectives of Army-wide scope and significance.

Military selection research includes research on selection and classification and on the evaluation of behavior involving unusual demands upon individuals, groups, or systems; also research in personnel systems relating such factors as manpower requirements and individual differences to systems effectiveness. Jobs are treated in the aggregate i.e., concern is with general, common factors in large classes of jobs.

Human performance experimentation studies behavioral functions which are important aspects of military human performance common to a number of Army jobs. Concern here is with task slices common to a variety of jobs.

Manned systems research involves study of a man's job in specific small-scale Army systems, wherein most of the factors involving man can be studied in their impact on the output of a particular system. Here concern is with study of a group of jobs in conjunction with sophisticated equipment.

Operations research relates to the evaluation of system performance (where the human element is critical), using simulation and optimization technology in the development and validation of behavioral models

BESRL scientists also render professional advice and assistance to all elements of Army staff and to major field command elements identified as sponsors and primary users, as well as to major field commands and to civilian organizations performing critical research in related areas.

BESRL scientists facilitate the implementation of its research findings, which are usually of Army-wide significance. These activities may include briefings, reporting, demonstrations, decision-making conferences, and the resolving of divergent scientific, practical and policy demands; they usually occur throughout the various phases of research, but particularly at the time of reporting final research results.

ORGANIZATION

The Commanding Officer of BESRL has responsibility for the accomplishment of the assigned mission. The Director has responsibility for the planning and conduct of the scientific program, which is carried out by an in-house staff on 135 augmented by contract resources. More than half are professionally trained psychologists, statisticians and mathematicians; the others are support personnel. A Deputy Director assists the Director in a staff capacity in each of the BESRL broad areas--military selection research, manned systems research, and human performance experimentation. Line authority for execution of the program extends from the Director to five Divisions, one of which lends statistical and computer support to the other four in addition to carrying out its research responsibilities.

A. CURRENT WORK PROGRAM

1. Surveillance Systems: Ground Surveillance and Target Acquisition Interpreter Techniques (Project 2J620901A721)

	Work Unit No.	Experimenter	Date Started	Estimated Completion
a.	0C2 Image Interpretation Displays	J. Zeidner A. H. Birnbaum BESRL, Wash., D. C.	May 63	Continuing

Objective is to specify changes in image interpretation performance resulting from variations in the images obtained by each of the sensors, the references of potential use to the interpreter, the viewing and image enhancement devices used to display or modify the images and references. The potential military research end-results are definitions of interpreter performance related to image quality variables for each of the major sensors, specifications for the development of interpreter references, equipment needs for viewers and utility estimates of image enhancement devices for use in future image interpretation systems, and operating procedures for use with new equipment. Studies investigating the effects of transmitted imagery will be conducted. The effects

of trade-off of thermal sensitivity and spatial resolution of IR senors will be studied, and the ability of interpreters to read the code data block matrix will be evaluated.

	Work Unit No.	Experimenter	Date Started	Estimated Completion
b.	003 Man-Computer Functions	J. Zeidner R. Sadacca BESRL, Wash., D. C.	May 63	Continuing

Objectives are to determine interpreter-computer input/output functions in an advanced image interpretation processing system; to evaluate input/output equipment and procedures; to develop procedures through which the computer can aid in the interpretation of decision process; to identify effective indexing systems, physical forms, storage and retrieval techniques, and display equipment for reference information within the system. The allocation of functions and interrelationships between interpreters and computers will be studied: how the computer can be used to increase quality and quantity of system's intelligence product; input/output equipment interposed between men and computer; interpreter-computer interface; use of computer derived probability estimates by interpreters; interpreter requirements for indexing and display of information.

	Work Unit No.	Experimenter	Date Started	Estimated Completion
c.	004 Component Integration	J. Zeidner R. Sadacca BESRL, Wash., D. C.	May 63	Continuing

Objectives are to determine number and type of interpreter duty stations within an advanced surveillance information processing system; to identify procedures for maintenance and improvement of personal proficiency within the system; to develop effective interpreter team procedures; to determine system control procedures, integration, evaluation and improvement of total system configuration. An interative procedure is required. As roles of interpreters within the system become better defined, research in computermediated instruction programs and internal feedback and review procedures will be initiated. Then research on control of information flow within the system will be undertaken. Finally, systematic manipulation of components of experimental systems will be done to evaluate alternate system configurations.

2. Image Characteristics and Interpreter Performance (Project 2J620901A732)

Work Unit No.	Experimenter	Date Started	Estimated Completion
001 Interpreter Techniques	J. Zeidner A.H. Birnbaum BESRL, Wash., D.C.	May 63	Continuing

Objectives are to improve quick-time interpretation techniques; to develop new change detection techniques incorporating the use of multisensor imagery; and to evaluate the utility of IR and SLAR sensor returns. An empirical, statistical approach will be employed. Performance indices will be obtained for screening and guide-line interpretation. Time-consuming, inaccurate and incomplete aspects will be identified and studied to determine their likely causes; techniques to remove or ameliorate them will be sought. Promising techniques will be developed and evaluated in controlled studies. Specific studies will investigate quick-time interpretation accuracy and multi-sensor interpretation.

3. Human Performance in Military Systems (Project 2J024701A723)

	Work Unit No.	Experimenter	Date Started	Estimated Completion
a.	001 Command Systems	J. Zeidner S. Ringel BESRL, Wash.,D.C.	Jul 63	Continuing

Objectives are to maximize combat effectiveness of Command Information Processing systems through the most efficient use of human abilities; to assist users, designers and developers of current and future command systems by providing empirical data concerning capabilities, limitations and reliability of human performance and implications for system design, allocation of functions among men and equipment, modes of presenting information for assimilation and decision making, and specification of effective individual and group work methods and procedures. Approach includes: 1) an in-house research program concerned with decision making, determination of human performance capabilities and the development of objective performance measures, 2) an in-house-contractual program designed to evaluate effectiveness of information transfer in a command systems context, 3) establishment of a field activity to work closely with ADFSC and Seventh Army on problems of human performance in a system under development.

	Work Unit No.	Experimenter	Date Started	Estimated Completion
b.	002 Monitor Performance	P.J. Bersh J. G. Tiedemann BESRL, Wash., D.C.	Jul 62	Continuing

Objectives are to develop general principles and techniques leading to work methods through which to increase the effectiveness of monitoring functions within a variety of Army jobs; to improve the performance of specific information monitoring personnel within Army Security Agency through the use of job engineering and personnel selection techniques. The potential military research end-result is the long range improvement of work methods for a broad spectrum of critical US Army monitoring jobs, and improved utilization of technical personnel within the Army Security Agency. Laboratory studies of monitoring behavior have been designed to extend vigilance research through utilization of a unique wide-range monitoring task simulator, the BESRL Vigilometer, which is capable of simulating the vigilance requirements of a variety of Army monitoring jobs.

	Work Unit No.	Experimenter	Date Started	Estimated Completion
c.	004 Combat Communications	P.J. Bersh G.E. Renaud BESRL, Wash.,D.C.	Jul 64	Continuing

Objectives are to increase the efficiency of radio-telephone communications in a tactical environment; to enhance the performance of transcribers and analysts in the extraction of information from communications media, and to develop improved human factors techniques for tactical electronic countermeasures. Research emphasis is on auditory capabilities of the operator. Laboratory studies include narrow-band filtering and other techniques to take advantage of the integrative and non-linear properties of the hearing mechanism, research on operator functions to deal with improvement of work methods and procedures, and improving the noise-and-distortion-resistant qualities of the message languages.

d.	008 Night Operations	P.J. Bersh J.J. Sternberg BESRL, Wash, D.C.	Jul 67	Continuing

Objectives are the identification of variables and parameters influencing perceptual performance during night operations; development of principles and techniques which will enhance perceptual performance during night operations; and evaluation and validation of resulting work methods and procedures leading to most effective utilization of appropriate personnel.

	Work Unit No.	Experimenter	Date Started	Estimated Completion
e.	009 Optimization Models	C.D. Johnson R.C. Sorenson BESRL, Wash., D.C.	Jul 67	Continuing

Objectives are to solve personnel management problems relating to the distribution, training and career progression and reassignment of personnel in both current and future systems; to analyze the personnel programs and identify areas where objective optimization techniques can be applied; to further develop quantitative techniques for management and provide consultative assistance regarding their application.

4. Selection and Behavioral Evaluation (Project 2J024701A722)

	Work Unit No.	Experimenter	Date Started	Estimated Completion
a.	001 Input Quality	E.F. Fuchs A.G. Bayroff BESRL, Wash.,D.C.	Jul 63	Jun 69

Objectives are to improve the system for screening potential enlisted input so as to identify and reject more effectively those who are not readily trainable and usable; to aid in manpower planning by developing methods for estimating the mental abilities of the civilian pool available for service under various conditions; to derive technical information for use in consultative assistance to staff agencies responsible for procurement and standards. Current effort includes: (1) Development of new forms of input screening tests for men and women and supplementary measures in line with research on new methods; (2) Conduct of methodological research basic to preparation of future operational measures; (3) Exploring the potential value and feasibility of programmed testing techniques without requiring a large research staff; (4) Development of methods for obtaining up-to-date information on the mental abilities of the civilian pool eligible for military service to include data on specific abilities as well as on overall ability; (5) Providing of technical consultative assistance to policy-making staff agencies.

	Work Unit No.	Experimenter	Date Started	Estimated Completion
b.	002 New Classification Techniques	E.F. Fuchs M.H. Maier BESRL, Wash.,D.C.	Jul 62	Continuing

Objectives are to maintain and improve effectiveness of initial classification so as to assign EM to make optimum use of their potential and developed skills and motivation in Army job performance; to identify personal characteristics of potential career men and those factors in personnel management affecting their retention, so as to provide career EM in the numbers needed in given occupational fields to meet Army force structure requirements. Current activity includes validation of 20

experimental predictors in the Army Differential MOS Battery, about half with motivational content, against training and job performance indices as potential additions to the current ACB; study of interaction of personal, social, and ability factors that affect failure to achieve at the level of one's abilities in training and on the job; development of measures relating to identification and retention of potential career EM.

	Work Unit No.	Experimenter	Date Started	Estimated Completion
c.	005 Officer Prediction	W.H. Helme L.P. Willemin BESRL, Wash., D.C.	Oct 63	Continuing

Objective is to develop improved techniques and prerequisites for selecting officers who have aptitudes and other characteristics that relate to successful performance in combat, administrative, or technical assignments and to predict career orientation of the more effective junior officers.

d.	006 Cadet Leaders	W.H. Helme L.J. Kotula BESRL, Wash., D.C.	Feb 63	Continuing

Objective is to improve selection procedures for primary officer procurement programs, particularly with respect to the problems of identifying leadership potential and career motivation among applicants for USMA and OCS and among ROTC trainees.

e.	014 Optimum Mental Distribution	E.F. Fuchs BESRL, Wash., D.C.	Oct 65	Continuing

The objective of the research is to develop measures of effectiveness of individuals and military units in order to determine impact of varying levels of enlisted input on Army performance. Using such measures of effectiveness, to determine the optimum numbers of personnel at various levels of ability which the Army can absorb for the most effective balance between maximum personnel effectiveness and reasonable training and supervision liabilities.

f.	015 Combat Performance	W.H. Helme F.F. Medland BESRL, Wash., D.C.	Mar 65	Continuing

Objectives are to identify the qualities required for effective performance in combat, including limited warfare situations; to develop selection techniques for men whose assignments require them to relate to and work effectively with personnel of other nations and cultures.

	Work Unit No.	Experimenter	Date Started	Estimated Completion
g.	016 Culture Fair Testing	W. H. Helme BESRL, Wash., D.C.	Jul 67	Continuing

The objective is to develop general methods and techniques for inst. uting military selection and classification systems which take into account dynamic cultural factors in selected countries.

5. Army Operations Analysis (Simulated Personnel Operations) (Project 2J050222M711)

	Work Unit No.	Experimenter	Date Started	Estimated Completion
a.	001 SIMPO I	C. D. Johnson R. C. Sorenson BESRL, Wash, D.C.	Jun 67	Continuing

Objectives are to analyze the personnel system to determine points at which decisions are made, operations which affect total system effectiveness, and criteria by which systems may be evaluated; to simulate the personnel systems in order to predict and to assess the total result of policy changes; to develop computer-aided research methods and tools that increase the Army's in-house capability for responding to personnel management research requirements.

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2D. U.S. ARMY BEHAVIORAL SCIENCE RESEARCH LABORATORY BIOGRAPHICAL DIRECTORY OF PROFESSIONAL PERSONNEL

UHLANER, JULIUS E., Director, BESRL; PhD, New York University, 1947, Psychology; Fellow, American Psychological Association, Washington Academy of Sciences; Member, Operations Research Society of America, Human Factors Society, Psychometric Society, Psychonomic Society, EPA, DCPA, SEPA, WPA; Phi Delta Kappa, Psi Chi; Member, Highway Research Board, Armed Forces--NRC Committee on Vision, Army Human Factors Research and Development Committee

BROWN, EMMA E. Assistant for Reports; MA, University of Colorado, 1927, Languages; Member, American Psychological Association, DCPA; Psi Chi, Phi Beta Kappa

DRUCKER, ARTHUR J., Assistant Director for Operations; PhD, Purdue University, 1949, Psychology; Fellow, American Psychological Association, Member, DCPA, EPA, International Association Applied Psychology

KAPLAN, HARRY, Assistant for Tests; PhD, George Washington University, 1967, Psychology; Member, American Psychological Association, EPA, AAAS, Psychometric Society

SASMOR, ROBERT M., Assistant for Plans; PhD, Columbia University, 1963, Experimental Psychology; Member, American Psychological Association, EPA, DCPA, Psychonomic Society, Human Factors Society, NY Academy of Sciences, AAAS: Fellow, Washington Academy of Sciences

BERSH, PHILIP J., Deputy Director for Human Performance Experimentation and Chief, Combat Systems Research Division; PhD, Columbia University, 1949, Experimental Psychology; Fellow, American Psychological Association, AAAS; Member, Psychonomic Society, EPA, NY Academy of Sciences, AF NRC-Vision Committee; Sigma Xi

BANKS, JAMES H., JR., Research Psychologist (E&P); PhD, University of Minnesota, 1959, Psychology; Member, American Psychological Association

CASTELNOVO, ANTHONY E., Research Psychologist (PM&E); MS, Kent State University, 1950, Psychology

DEAN, RICHARD, Research Psychologist (E&P); MS, University of Maryland, 1962, General Experimental Psychology; Associate Member, American Psychological Association, American Statistical Association, Human Factors Society, DCPA

FARRELL, JOHN P., JR., Research Psychologist (E&P); MA, The Catholic University of America, 1965, Psychology

FEIL, RICHARD, Research Psychologist (E&P); MA, The Catholic University of America, 1963, Experimental Psychology; (all course work toward PhD completed); Associate Member, American Psychological Association; Sigma Xi, Psi Chi

KAPLAN, MICHAEL, Principal Scientist; PhD, Columbia University, 1952, Experimental Psychology; Member, American Psychological Association, EPA, AAAS, New York Academy of Sciences, Society for Psychophysiological Research; Sigma Xi, Phi Beta Kappa

RENAUD, GEORGE E., Sr. Task Leader; AM, Columbia University, 1951, Experimental Psychology (course work and research completed for PhD, Columbia University); Member, Committee on Hearing, Bio-Acoustics, and Bio-Mechanics (CHABA): Sigma Xi

STERNBERG, JACK J., Sr. Task Leader; MA, Syracuse University, 1950, Psychology and Statistics; Member, Psychometric Society; Psi Chi

STICHMAN, EUGENE P., Research Psychologist (General); AB, Dartmouth College, 1957, Psychology; Member, AAAS

TIEDEMANN, JOHN G., Sr. Task Leader; PhD, American University, 1961, Psychology; Treasurer, DCPA; Fellow, American Psychological Association; Member, AAAS; Psi Chi

FUCHS, EDMUND F., Deputy Director for Selection Research and Chief, Military Selection Research Division; MA, Fordham University, 1942, Psychology; Fellow, AAAS, American Psychological Association; Member, Md. PA, Midwestern PA, DCPA, Board of Civil Service Examiners; Diplomate (Ind Psych) ABEPP

BAYROFF, ABRAM G., Sr. Task Leader; PhD, University of North Carolina, 1931, Psychology; Fellow, American Psychological Association, AAAS; Member, EPA, DCPA (President-elect), SEPA, Psychonomic Society; Sigma Xi; Diplomate (Ind Psych) ABEPP

ELLIS, EMILLIE F., Research Psychologist (PM&E); BA, George Washington University, 1964, Psychology

KRISTIANSEN, DONALD M., Research Psychologist (PM&E); MS, Iowa State University, 1961, Psychology; Associate, American Psychological Association

MAIER, MILTON H., Sr. Task Leader; PhD, Purdue University, 1959, Psychology; Member, American Psychological Association, Psychometric Society

MORTON, MARY A., Research Psychologist (PM&E); MS, Howard University, 1934, Psychology; Member, American Psychological Association, DCPA

ROSS, ROBERT M., Research Psychologist (PM&E); BA, Brandeis University, 1959, Psychology

SEELEY, LEONARD C., Sr. Research Psychologist (PM&E); MA, American University, 1958, Psychology; Member, American Psychological Association, EPA

HELME, WILLIAM H., Chief, Behavioral Evaluation Research Division; PhD, New School for Social Research, 1959, Psychology; Member, American Psychological Association, EPA

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2E. HUMAN RESOURCES RESEARCH OFFICE

Alexandria, Virginia 22314

A. CURRENT WORK PROGRAM*

The HumRRO Work Program is concerned with human factors research in training, motivation and leadership. Research aimed at solving practical military problems is carried on by seven research groups: Division No. 1 (System Operations) and Division No. 7 (Language and Area Training) in Alexandria, Virginia, and Division No. 2 (Armor) at Ft. Knox, Kentucky, Division No. 3 (Recruit Training) at Presidio of Monterey, California, Division No. 4 (Infantry) at Ft. Benning, Georgia, Division No. 5 (Air Defense) at Ft. Bliss, Texas, and Division No. 6 (Aviation) at Ft. Rucker, Alabama co-located with Headquarters, USCONARC, Human Research Units. In addition, a basic research program is being conducted by several research groups. Each research division provides Technical Advisory Service to assist the Army in planning implementation of research results and to meet other Army requests. Exploratory studies aimed at identifying human factors problems likely to arise in future military operations are also conducted by the research divisions.

The 6-digit alphanumeric serial number which appears with each Work Unit and Basic Research Study is the agency accession number as given on the Research and Technology Resume (DD Form 1498) (Block 3).

The Work Units and Work Unit objectives, for Fiscal Year 1968, grouped by Work Category, are given in the following list. This list includes also the Exploratory Studies for Fiscal Year 1968.

*A copy of the complete Work Program for FY 1968 is available on re - quest to the Director, Human Resources Research Office, 300 No. Washington Street, Alexandria, Virginia 22314

Work Unit No.	Experimenter(s)	Date Started	Estimated Completion
OA 9875	Mr. E. Wayne Frederickson Mr. Robert J. Foskett Mr. Michael R. McCluskey Dr. Richard E. Wienke Dr. Albert L. Kubala Mr. Walter E. Burrell	06 66	Continuing

SKYFIRE - Training Methods for Forward Area Air Denfense Weapons

Objective - To determine man's capabilities to perform the operator skills required by forward area air defense weapons and to identify effective training concepts for developing the required skills.

SPECTRUM - Design of Training for Marginal and Exceptional Aptitude Trainees

Objective - To investigate the relation between learning abilities in different categories of learning tasks representative of entry-level training in common, high-density MOSs, and various aptitude levels, with special emphasis on low aptitude, marginal personnel. The purpose is to discover methods for selecting and organizing training content and for presenting and managing training methods in order to achieve more effective training at all aptitude levels.

OA 9868	Dr. Paul G. Whitmore Mr. Arthur C. Vicory Mr. Carl W. Polvogt	07 65	Continuing

STAR - Aircraft Recongnition Training

Objective - To develop concepts of aircraft recognition training suitable for personnel manning all forward area air defense weapons.

OA 9877	Dr. Douglas L. Grimsley Dr. Robert D. McDonald	07 66	Continuing

STRANGER - Long-Term Memory of Motor Skills

Objective - To examine and obtain a better understanding of long-term memory of motor skills.

OA 9874	Dr. Joseph S. Ward COL Nelson I. Fooks (USA-Ret.) Dr. S. James Goffard Dr. Richard P. Kern	05 66	Continuing

Work Unit No.	Experimenter(s)	Date Started	Estimated Completion

SUPPORT - Development of Improved Training for Combat Support Programs

Objective - To develop improved individual training programs for Combat Support MOSs through human factors research on training objectives, content, methods, and procedures.

OA 9879	Mr. Russel E. Shulz Mr. Warren P. Pauley Mr. John C. Duffy	07 66	Continuing

UPGRADE - Improving Aviation Maintenance Training Through Task and Instructional Analysis

Objective - To develop a model system in aviation maintenance training for relating instructional objectives to task behaviors; to apply the model system to development of UH-1 helicopter maintenance training; and to develop mentods and procedures to allow application of the model system to other aviation maintenance training courses.

OA 9886	Dr. S. James Goffard Dr. Robert Vineberg	11 66	Continuing

UTILITY - Study of Men in Lower Mental Categories: Job Performances and the Identification of Potentially Successful and Potentially Unsuccessful Men

Objective - To compare the job proficiency and overall military suitability of personnel in Mental Category IV and other mental categories in selected MOSs; to identify characteristics of these men associated with successful and unsuccessful performance; and to demonstrate the utility of background and noncognitive information in the screening and the differential classification and assignment of men of lower mental ability.

OA 9865	Mr. Donald L. Wright Mr. William L. Warnick Mr. Richard A. Kulp Mr. William N. Gipe Mr. John V. Kiesler	07 65	Continuing

NIGHTSIGHTS - Training Techniques for Passive Night Vision Devices

Objective - To identify critical human factors problems in the use of new passive night vision devices, and to develop effective techniques of training in the use of the devices.

Work Unit No.	Experimenter(s)	Date Started	Estimated Completion
OC 9810	Dr. A. James McKnight Dr. Richard D. Behringer Mr. Harold Wagner Mr. James R. Lodge	07 67	Continuing

JACK - Project 100,000: Development of Comprehensive Test for Signal Terminal Operators

Objective - To develop a comprehensive test to evaluate the effectiveness of the revised Signal Terminal Operators course prepared by the U. S. Army Southeastern Signal School.

OC 9809	Dr. Edgar L. Shriver Mr. Patrick Butler	07 67	Continuing

STOCK - Project 100,000: Evaluation of the Supplyman Training Program

Objective - To (1) evaluate the effectiveness of the revised Supplyman course prepared by the U.S. Army Quartermaster School (QMS), and (2) to identify critical supply training problems caused by the introduction of Project 100,000 personnel.

OC 9811	Dr. Richard P. Kern	07 67	Continuing

SKILLCON - Curriculum Engineering of Combat Training to Enhance the Soldier's Resistance to Combat Stress

Objective - To perform curriculum engineering on specific aspects of instruction in Basic Combat Training (BCT) and Advanced Individual Training (AIT) to produce training that would strengthen the soldier's resistance to stress in combat and hazardous duty situations, and if feasible, to develop guidelines or procedures that would enable trainers to similarly improve training in other areas of combat or hazardous duty performance.

OC 9812	Mr. E. Wayne Frederickson Mr. Michael R. McCluskey	07 67	Continuing

TESTAID - Technical Assistance in the Design and Execution of JTF-2 Test 3.1/3.5

Objective - To provide technical assistance to Joint Task Force Two (JTF-2) in the design of field tests and computer modelling of the effectiveness of ground based air defense weapons.

Work Category 2: Small-Unit Training and Performance

Project No. 2J024701A712 01

Work Unit No.	Experimenter(s)	Date Started	Estimated Completion
OA 9866	Mr. Eugene H. Drucker Mr. J. Roger Ware Mr. Richard A. Kulp	07 65	Continuing

ENDURE - Tank Crew Performance During Periods of Extended Combat

Objective - To determine the endurance of troops using combat equipment with a 48-hour capability and, as necessary, to establish ways of extending troops' endurance so that the effectiveness of the equipment will not be limited by the user.

OA 9842	Dr. Clay E. George	09 62	12 67

UNIFECT - Procedures for Increasing the Effectiveness of Small Infantry-Type Units

Objective - To develop procedures for team training that will produce teamwork while teaching current technical content; to apply the procedures to the design of rifle squad training; to conduct field tests of the adequacy of the training; and to produce a guidebook for use by trainers, leaders, and umpires.

Work Category 3: Training for Leadership, Command, and Control

OA 9872	Dr. T. O. Jacobs LTC George J. Magner (Ret) Mr. George Hoak	02 66	Continuing

ACTION - Research for Improvement of Infantry Counterinsurgency Training

Objective - To develop the information basis for (1) improved counter-insurgency infantry training, and (2) a debriefing system for combat veterans.

Work Unit No.	Experimenter(s)	Date Started	Estimated Completion
OA 9888	Dr. James Dees LTC George J. Magner (Ret)	07 67	Continuing

CONTROL - Control in Small Infantry Units

Objective - To study factors that influence the controllability of small infantry units, with reference to the future design of units.

OA 9891	Dr. Joseph A. Olmstead, Jr. Mr. G. F. Mascaro	07 67	Continuing

FORGE - Factors in Organizational Effectiveness

Objective - To identify and discover ways of controlling human factors that influence the effectiveness of military organizations.

OA 9844	Dr. T. O. Jacobs LTC Frank L. Brown (Ret) Mr. T. R. Powers COL Arthur J. DeLuca (Ret)	07 62	Continuing

LEAD - Development of Training for Improving the Combat Skills of Leaders in Small Infantry Units

Objective - To improve officer training in the critical skills required for effective combat leadership in small infantry units.

OA 9884	Dr. Harry L. Ammerman Dr. William H. Melching Mr. Judson D. Human Mr. Leonard E. Ryan Mr. Richard C. Montgomery	07 66	Continuing

MANICON - Determination of Performance Capabilities and Training Requirements for Manual Command and Control Functions of the NIKE-X Weapon System

Objective - To identify and evaluate manual performance capabilities and training requirements for command and control functions within the NIKE-X weapon system, in direct support of the NIKE-X Engineering/ Service Test and Evaluation Program Activity.

OA 9885	Dr. Douglas S. Holmes Miss Janet F. Lingle	01 67	06 68

WACLEAD - Research for the Expansion and Improvement of the WAC Leadership Training Course for Junior Officers

Objective - To conduct research for expanding and improving the WAC leadership training course for junior officers.

Work Category 4:
Language and Area Training

Project No. 2J024701A712 01

Work Unit No.	Experimenter(s)	Date Started	Estimated Completion
OA 9853	Dr. Alfred J. Kraemer Dr. R. J. Foster Dr. J. Danielian Mr. T. A. Akter Mr. J. C. D'Mello	03 63	Continuing

AREA - Development of Concepts and Techniques for Area Training

Objective - To increase the effectiveness of area training.

OA 9854	Dr. George H. Brown Dr. Richard Beym	07 63	Continuing

AUTOSPAN - Development and Evaluation of a Self-Instructional Method for Learning a Foreign Language

Objective - To develop and evaluate a self-instructional method for learning a foreign lanuage at an introductory level. Such development will be approached through the design, construction, and evaluation of a self-instructional Spanish course.

OA 9855	Dr. Alfred J. Kraemer Dr. A. H. Niehoff	06 63	12 67

CIVIC - Guidelines for Civic Action Advisors

Objective - To provide civic action advisors with guidelines for civic action program development.

OA 9892	Dr. A. J. Draemer	07 67	Continuing

COPE - Development of Programed Audio-Visual Instruction for Cross-Cultural Effectiveness

Objective - To increase the effectiveness of mission officers in their work with foreign personnel through development of programed audio-visual instruction for use in area training.

OA 9856	Dr. Arthur J. Hoehn Dr. D. K. Froehlich	07 63	Continuing

Work Unit No.	Experimenter(s)	Date Started	Estimated Completion

MAP - Development of Guidelines for Training Personnel for Military Assistance Advisory Duties

Objective - To improve the effectiveness of military assistance advisors by studying the functions, problems, and advisory methods of such personnel, with the aim of developing appropriate guidelines for training.

OC 9813	BG Samuel G. Taxis (USMC Ret)	07 67	Continuing

DEBRIEF - Feasibility Study on a System for Debriefing MAAG Advisors

Objective - To develop and evaluate techniques and instruments for debriefing U.S. military personnel who have served overseas in the Military Assistance Program, and methods for processing and disseminating the information thus obtained.

OC 9814	Dr. Jose Armilla	07 67	Continuing

REFOCUS - Implementation and Modification of a System for Debriefing MAAG Advisors

Objective - To develop and evaluate techniques and instruments for the systematic continuation and modification of the Advisor Debriefing Program within USMACTHAI which will serve to (1) focus the current research effort more directly upon the local situation, (2) provide for timely revision of data collection instruments in order to reflect changes in the local situation, (3) insure continuity in data collection, and (4) assist USMACTHAI in the interpretation, evaluation, and utilization of the information provided by this and related efforts.

OC 9815	Dr. Harley M. Upchurch	07 67	Continuing

SOJOURN - Overseas Military Posts and Communities

Objective - To develop and illustrate the application of methods for obtaining information relevant to the management, organization, and planning of overseas American military communities.

OC 9816	Dr. Robert J. Foster	07 67	Continuing

COMSERVE - Development of manual for Community Service Volunteers

Objective - To develop a manual to assist in the recruitment, training and utilization of volunteers in the Army Community Service Program.

Work Category 5: Training Technology

Project No. 2J024701A712 01

Work Unit No.	Experimenter(s)	Date Started	Estimated Completion
OA 9890	Dr. Robert J. Seidel Dr. Felix Kopstein Mr. Richard Rosenblatt Mr. Donald R. Gruver	05 67	Continuing

IMPACT - Instruction Model/Prototypes Attainable in Computerized Training

Objective - To develop (1) a prototype computer-administered instructional system with (2) accompanying prototype multiple-track (branching) individualized programs of instruction.

OA 9867	Dr. Robert A. Baker Mr. John G. Cook	07 66	Continuing

SIMULATE - Development of New Simulation and Miniaturization Concepts to Meet Army Needs

Objective - To conduct exploratory development in the application of concepts and techniques of simulation and miniaturization to training in several high-priority Army skills.

OA 9882	Dr. Norman Willard	10 66	Continuing

TRAINMAN - Development of an Instructional Program in Training Technology and Training Management

Objective - To develop an instructional program on training technology and training management with particular attention directed toward advances and new concepts.

Following is the list of Basic Research Studies grouped by Work Categories for Fiscal Year 1968.

Work Category 1: Individual Training and Performance

BR-16 - Visual Pattern Discrimination

Work Category 5:
Training Technology

BR-8 - Common Job Elements
BR-14 - Prompting and Guidance
BR-18 - Reinforcement Management
BR-19 - Learner Material Interaction

Following is the List of Exploratory Studies grouped by Work Categories for Fiscal Year 1968.

Work Category 1:
Individual Training and Performance

ES-50 - Aviator Stress
ES-60 - Troop Indoctrination
ES-61 - Reconnaissance and Surveillance
ES-72 - Accident Data Analysis

Work Category 2:
Unit Training and Performance

ES-54 - Human Performance Degradation

Work Category 3:
Training for Leadership, Command, and Control

ES-64 - Battalion Leadership

Work Category 6:
Training Management

ES-70 - Longitudinal Analysis

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Wright, Robert H. "Some comments on the display of cartographic information for very low level flight," paper for Symposium on Aeronautical Charts and Map Displays, office of Naval Research, Department of the Navy, Washington, November 1966; issued as HumRRO Professional Paper 13-67, March 1967.

Zook, Lola M. "Training the editor: skills are not enough," paper for symposium at International Technical Communications Conference Society of Technical Writers and Publishers, Chicago, May 1967; issued as HumRRO Professional Paper 28-67, June 1967.

2E. HUMAN RESOURCES RESEARCH OFFICE BIOGRAPHICAL DIRECTORY OF PROFESSIONAL PERSONNEL

OFFICE OF THE DIRECTOR, 300 NO. WASHINGTON, STREET, ALEXANDRIA, VIRGINIA 22314

COGAN, EUGENE A., Assistant Director for Reporting; PhD, U.C.L.A., 1951, Psychology; Sigma Xi; Psi Chi; APA; AAAS; NGA; WORC.

CRAWFORD, MEREDITH P., Director; PhD, Columbia University, 1935, Psychology; Phi Beta Kappa; Sigma Xi; Fellow, APA; AAAS; MPA; EPA; D.C.P.A.; CC; AUSA; PS; N.R.C.; CAREL.

HOFFMAN, DAVID S., Chief, I.P.S.; MS, University of Pittsburgh, 1952, Mach; SIAM; ACM; MAA; AAAS.

LANGE, CARL J., Assistant Director for Planning; PhD, University of Pittsburgh, 1951, Psychology; Sigma Xi; Fellow, APA; D. C. P. A.; SSPP; License, Virginia.

LAVISKY, SAUL, Research Information Coordinator; MA, University of South Carolina, 1961, Journalism; MGA: ROA; AUSA; NSPRA; PPA; NEA; AERA; ASCD.

MC CLELLAND, WILLIAM A., Associate Director; PhD, University of Minnesota, 1948, Psychology; Phi Beta Kappa; Sigma Xi; Fellow, APA; Certified D.C.P.A.; PS; EPA; MPA; AAAS; License, Virginia.

SHEPHERD, ALBERT L., Representative at CONARC; MEd, William and Mary, 1952, School Administration.

SMITH, CHARLES W., Business Administrator; LLB, George Washington University, 1953, Law.

SMITH, ROBERT G., JR., Assistant Director for Operations; PhD, University of Illinois, 1950, Psychology; Fellow, APA; NSPI; License, Virginia.

ZOOK, LOLA M., Editorial Advisor and Publications Manager; AB, University of Iowa, 1930, Journalism; Phi Beta Kappa; Theta Sigma Phi, STWP.

DIVISION NO. 1 (SYSTEM OPERATIONS) 300 NO. WASHINGTON STREET, ALEXANDRIA, VIRGINIA 22314

AYERS, JOHN K., Senior Technician; AB, University of Alabama, 1939, Political Science, Economics, Public Administration.

BEHRINGER, RICHARD D., Research Scientist; PhD, University of Delaware, 1966, Psychology; Sigma Xi; Psi Chi; APA.

BRADEN, HUGO, F., Technician; BS, University of Alabama, 1962, Physics; Sigma Pi Sigma.

BUTLER, PATRICK J., Research Scientist; MA, University of South Carolina, 1957, Psychology; Psi Chi; EIA.

FINK, C. DENNIS, Senior Staff Scientist; PhD, University of Colorado, 1958, Psychology; APA; ADI.

GRUVER, DONALD R., Technician; BA, George Washington University, 1955, American Thought And Civilization.

HIBBITS, FRANCIS L., Technician; BS, University of Rhode Island, 1937, Biology.

HUNTER, BEVERLY R., Senior Technician; BA, University of Pittsburgh, 1963, Philosophy, Political Science; DAVI; NSPI; ENTELEK.

HUNTER,HAROLD G., Senior Scientist; PhD, Washington State University, 1965, Psychology; Psi Chi; APA; Sigma Xi.

KOPSTEIN, FELIX F., Senior Scientist; PhD, University of Illinois, 1960, Pshchology; APA; IAAP; AERA; IEEE; SGSR; NSPI.

LEEDY, HERBERT B., Research Scientist; PhD, Purdue University, 1963, Psychology; Psi Chi; Sigma Xi; APA.

LODGE, JAMES R., Research Assistant.

LYONS, J. DANIEL, Director of Research; PhD, University of Illinois, 1953, Psychology; Sigma Xi; Sigma Pi Sigma; Fellow, APA; SEPA; MPA; SSPP; VPA; HFS; WORC.

MC KNIGHT, A. JAMES, Senior Staff Scientist; PhD, University of Minnesota, 1958, Psychology; Psi Chi; APA; HFS; HRB.

PROCTOR, ROY M., Senior Scientist; MA, Michigan State University, 1960, Philosophy; Delta Phi Epsilon.

ROSENBLATT, RICHARD D., Research Associate; BS, University of Baltimore, 1962, Business Administration, Psychology; Psi Chi.

SEIDEL, ROBERT J., Senior Staff Scientist; PhD, University of Pennsylvania, 1957, Psychology; Phi Beta Kappa; Sigma Xi; APA; EPA; PS; NSPI.

SHRIVER, EDGAR L., Senior Staff Scientist; PhD, University of Pittsburgh, 1953, Psychology; APA; AAAS; WORC; AMS; IPA.

TREXLER, ROBERT C., Senior Staff Technician; BS, Massachusetts Institute of Technology, 1954, Electrical Engineering; I.E.E.E.; PG; HFE; EM.

WAGNER, HAROLD, Research Scientist; BBA, City College of New York, 1959, Psychology; Psi Chi; Sigma Xi; AAAS; APA; EPA.

DIVISION NO. 2 (ARMOR) FORT KNOX, KENTUCKY 40121

BATTRICK, WILLIAM T., Senior Technician; MA, University of Colorado, 1939, English; STWP.

BAKER, ROBERT A., Senior Staff Scientist; PhD, Stanford University, 1952, Psychology; Sigma Xi; Fellow, APA; AMS; KPA; MPA; PS; SEPA; License, Kentucky.

BOYCAN, GEORGE G., Research Associate; MA, University of Detroit, 1967, Psychology.

CANNON, L. DENNIS, Senior Scientist; PhD, Purdue University, 1959, Psychology; Psi Chi; Sigma Xi; APA; MPA; SEPA.

CASSILETH, BARRIE R., Research Associate; MS, Yeshiva Graduate School of Education, 1961, Psychology.

COOK, JOHN G., Senior Technician.

DRUCKER, EUGENE H., Research Scientist; MA, University of Kentucky, 1958, Psychology; APA; MPA; SEPA.

EASLEY, DAVID L., Senior Scientist; PhD, Vanderbilt University, 1956, Psychology; Sigma Xi; APA; SEPA; MPA; KPA; License, Kentucky.

HAGGARD, DONALD F., Senior Staff Scientist; PhD, State University of Iowa, Psychology; Sigma Xi; APA; MPA; PS.

KRAEMER, RONALD E., Research Assistant; BA, Bellarmine College, 1966, Psychology.

KULP, RICHARD A., Research Associate, MA, University of Louisville, 1966, Psychology; SSPP; KPA; MPA; Psi Chi; Phi Kappa Phi.

MILLER, ELMO, E., Senior Scientist; PhD, University of Minnesota, 1958, Pshchology; Phi Beta Kappa; APA; KPA; Magna Cum Laude.

OSBORN, WILLIAM C., Research Scientist; MS, Purdue University, 1959, Psychology; Sigma Xi; MPA.

SCHULMAN, RICHARD M., Research Scientist; PhD, University of Rochester, 1965, Pshchology; Sigma Xi; APA; EPA; AAAS; MPA.

SCHWARTZ, SHEPARD, Senior Scientist; BA, Long Island University, 1933, Sociology; AERA;ASS; SO.

SHELDON, RICHARD W., Research Scientist; PhD, State University of Iowa, 1961, Psychology; APA; ASTA.

WARE, J. ROGER, Research Associate; MA, University of Louisville, 1961, Psychology.

WARNICK, WILLIAM L., Technician; BA, University of Pittsburgh, 1953, History.

WILLARD, NORMAN, JR., Director of Research; PhD, University of Minnesota 1954, Pshchology; Sigma Xi; APA; AAAS; AMS; KPA; MPA; License, Kentucky.

WRIGHT, DONALD L., Research Associate; MA, Ohio University, 1965, Psychology.

<u>DIVISION NO. 3 (RECRUIT TRAINING) P.O. BOX 5787,</u>
<u>PRESIDIO OF MONTEREY, CALIFORNIA 93940</u>

BRENNAN, MARK F., Research Associate; BS,West Point, 1938, Math, Engineering, Languages; Assoc. of Graduates, U.S. Military Academy; Assoc. of U.S. Army.

BURDICK, HARRY A. Research Scientist; PhD, University of Michigan, 1957, Psychology; APA; TAA; WPA.

CAYLOR, JOHN S., Senior Scientist; PhD, University of Michigan, 1956, Psychology; APA; WPA.

FOOKS, NELSON I., Senior Technician; BS, West Point, 1927, Engineering.

FOX, WAYNE L., Research Scientist; PhD, University of Arizona, 1966, Psychology; Sigma Xi; Psi Chi; WPA.

GERJUOY, HERBERT G., Senior Staff Scientist; PhD, State University of Iowa, 1953, Psychology; APA; HFS; PMS; ASA; AAAS; MPA; EPA.

GOFFARD, S. JAMES, Senior Staff Scientist; PhD, University of Minnesota, 1949, Psychology; Phi Beta Kappa; Sigma Xi; Phi Kappa Phi; APA.

GRIMSLEY, DOUGLAS L., Research Scientist; PhD, Syracuse University, 1964, Psychology; APA; AAAS.

KERN, RICHARD P., Senior Scientist; PhD, State University of Iowa, 1953, Pshchology; Sigma Xi; Psi Chi; APA; WPA; AAAS.

MC DONALD, ROBERT D., Senior Scientist; PhD, Syracuse University, 1963, Psychology; APA; AAAS; ISB.

MC FANN, HOWARD H., Director of Research; PhD, State University of Iowa, 1952, Psychology; Sigma Xi; Fellow, APA; WPA; AAAS; PS; Member, APA Div. 15.

MONTAGUE, ERNEST K., Senior Scientist; PhD, State University of Iowa, 1950, Pshchology; Phi Betta Kappa; Sigma Xi; Fellow, APA (Divisions 12 and 19); Fellow, AAAS; Diplomae ABEPP (clinical); AERA; Phi Delta Kappa.

POLDEN, DONALD F., Senior Technician; MA, George Washington University, 1965, Personnel Administration.

SHOWEL, MORRIS, Senior Scientist; PhD, Washington State University, 1952, Sociology; ASA; PSA.

STICHT, THOMAS G., Research Scientist; PhD, University of Arizona, 1965, Psychology; APA; PS; SSPP.

TAYLOR, ELAINE N., Senior Scientist; PhD, State University of Iowa, 1954, Psychology; Sigma Xi.

TAYLOR, JOHN E., Senior Staff Scientist; PhD, State University of Iowa, 1953, Psychology; Sigma Xi; APA; MWPA; WPA; PS; AAAS.

VILJOEN, BENJAMIN, Senior Technician.

VINEBERG, ROBERT, Senior Staff Scientist; PhD, New York University, 1959, Psychology; Sigma Xi; Fellow, APA; PS.

WARD, JOSEPH S., Senior Staff Scientist; PhD, Tulane University, 1959, Psychology; Sigma Xi.

DIVISION NO. 4 (INFANTRY) P. O. BOX 2086, FORT BENNING, GEORGIA 31905

BROWN, FRANK L., Senior Staff Technician; BS,Clarion Technical College, 1956, Secondary Education; SA; SEPA.

DEES, JAMES W., Senior Scientist; PhD, University of Tennessee, 1962, Psychology; APA; MPA; AAAS.

DE LUCA, ARTHUR J., Research Scientist; MA, Toledo University, 1964, Liberal Arts.

HARRIS, LYMAN K., Technician.

HOAK, GEORGE R., Research Associate; BS, Central Michigan University, 1959, Sociology.

HOLMES, DOUGLAS, Senior Scientist; PhD, University of Wisconsin, 1963, Psychology; APA.

JACOBS, T. OWEN, Director of Research; PhD, University of Pittsburgh, 1956, Psychology; APA; SEPA; SSPP; PMS; GPA; MPA.

LINGLE, JANET F., Research Associate; MA, Temple University, 1965, Psychology

MAGNER, GEORGE J., Technician.

OLMSTEAD, JOSEPH A., Senior Staff Scientist; PhD, University of Texas, 1956, Pshchology; Phi Beta Kappa; APA; SEPA; Sigma Xi.

POWERS, THEODORE R., Senior Scientist; MA, University of Kentucky, 1956, Psychology.

ROECKELEIN, JON E., Research Associate; MA, University of Buffalo, 1965, Psychology.

DIVISION NO. 5 (AIR DEFENSE) P. O. BOX 6021, FORT BLISS, TEXAS 79916

AMERMAN, HARRY L. , Senior Scientist; PhD, Purdue University, 1960, Industrial Psychology; Sigma Xi; APA; MPA; SWPA; Certified, Texas.

BALDWIN, ROBERT D., Director of Research; PhD, University of Iowa, 1954, Psychology; APA; MPA.

BURRELL, WALTER, E., Technician; BS, Kansas State College, Mechanical Engineering.

CHRISTENSEN, HAROLD E., Research Scientist; MS, University of Utah, 1960, Psychology; APA.

FOSKETT, ROBERT J., Research Associate; BEE, Ohio State, 1962, Electrical Engineering.

FREDERICKSON, EDWARD W., Research Scientist; MA, Baylor University, 1961, Psychology.

HARRIS, JULIA S., Research Scientist; BSC, University of Louisville, 1954, Business Administration.

HUMAN, JUDSON D., Research Assistant; BA, Southern Methodist University, 1964, Psychology, French; Pi Delta Phi.

KUBALA, ALBERT L., Senior Scientist; PhD, University of Texas, 1956, Psychology; APA.

KUZA, WILLIAM W., Technician; EE, Wentworth Institute, 1958, Electronics.

MC CLUSKEY, MICHAEL R., Research Associate; MA, Texas Christian, 1965, Psychology.

MELCHING, WILLIAM H., Senior Scientist; PhD, U.C.L.A., 1953, Psychology; Sigma Xi; APA; SWPA; NSPI.

NEAL, GILBERT L., Research Scientist; PhD, University of Oklahoma, 1966, Psychology; APA; MPA; SWPA; AAP.

POLVOGT, CARL W., JR., Senior Technician; BS, University of Texas, 1951, Art.

RANKIN, WILLIAM, Research Assistant; MA, University of Omaha, 1963, Industrial, General-Experimental Psychology; SWPA.

ROGERS, JAMES P., Senior Scientist; PhD, Emory University, 1956, Psychology; Sigma Xi; APA; AOA.

RYAN, LEONARD E., Research Associate; BS, University of Houston, 1962, Psychology.

VICORY, ARTHUR C., Research Associate; MA, San Jose State College, 1963, Industrial & Experimental (Human Learning).

WIENKE, RICHARD E., Senior Scientist; PhD, University of Illinois, 1955, Psychology, MPA; SWPA; Sigma Xi.

WOOD, ROBERT O., Research Scientist; MS, Trinity University, 1962, Psychology.

WHITMORE, PAUL G., Senior Scientist; PhD, University of Tennessee, 1956, General-Experimental Psychology; APA; SEPA; MPA; SWPA; AAAS.

WRIGHT, A. DEAN, Senior Scientist; MS, Fort Hays Kansas State College, 1959, Psychology; SWPA.

DIVISION NO. 6 (AVIATION) P. O. BOX 428, FORT RUCKER, ALABAMA 36360

BOYD, H. ALTON, JR., Research Scientist; MS, North Carolina State University, 1965, Psychology.

BOYLES, WILEY R., Senior Scientist; PhD, University of Tennessee, 1961, Psychology; Sigma Xi; APA; SEPA; Ala. PA

CARO, PAUL W., JR., Senior Scientist; PhD, University of Tennessee, 1961, Psychology; Sigma Xi; APA; SEPA; Ala. PA; AAP; AHS; License, Alabama.

COCHRAN, CARL DWAINE, Research Scientist; PhD, University of Georgia, 1967, Psychology; Sigma Xi; Psi Chi.

DUFFY, JOHN O., Research Associate; MA, University of Southern California, 1949, Psychology; APA; Ala. PA; EPA; AAP; License, Alabama.

ISLEY, ROBERT N., Research Associate; BA, Wayne State University, 1960, Psychology; Psi Chi.

JOLLEY, ORAN B., Senior Technician; AAAA; AHS; QB.

PAULEY, WARREN P., Technician.

PROPHET, WALLACE W., Director of Research; PhD, University of Florida, 1958, Psychology; Phi Beta Kappa; APA; FPA; SEPA; Ala. PA; AAAA; AAP; License, Alabama.

SCHULZ, RUSSEL E., Research Scientist; MA, Michigan State, 1958, Psychology.

THOMAS, FRANCIS H., Senior Staff Scientist; PhD, Cornell University, 1953, Psychology; Fellow, APA; Ala. PA; HFS; Armed Forces-National Research Council Committee on Vision.

DIVISION NO. 7 (LANGUAGE & AREA TRAINING) 300 NO. WASHINGTON STREET, ALEXANDRIA, VIRGINIA 22314

ARMILLA, JOSE, Research Scientist; PhD, University of Michigan, 1960, Psychology; APA.

BEYM, RICHARD, Senior Scientist; PhD, University of Illinois, 1952, Spanish Linguistics; AATSP; LSA; MLA; TESOL; WLC.

BROWN, GEORGE H., Senior Scientist; PhD, New York University, 1952, Psychology; APA; EPA.

CORBINO, JEROME P., Research Assistant; BS, University of Illinois, 1964, Psychology.

DANIELIAN, JACK S., Research Scientist; PhD, Columbia University, 1964, Social Psychology; APA; EPA; SPSSI.

FIKS, ALFRED I., Senior Scientist; PhD, Purdue University, 1962, Psychology; APA; SPSSI; AFS.

FOSTER, ROBERT J., Senior Scientist; PhD, University of Texas, 1960, Psychology; APA; SPSSI.

FROEHLICH, DEAN K., Senior Scientist; PhD, University of Illinois, 1961, Psychology; APA; Sigma Xi; RAS; KAF.

HAVERLAND, EDGAR M., Senior Scientist; PhD, University of Illinois, 1954, Psychology; APA; MPA; PMS.

HOEHN, ARTHUR J., Director of Research; PhD, University of Illinois, 1951, Psychology; APA; D.C.P.A.; MPA.

KRAEMER, ALFRED J., Senior Staff Scientist; PhD, Vanderbilt University, 1957, Psychology; APA; SPSSI; AAPSS; SID.

MC CRARY, JOHN W., Senior Scientist; PhD, Brown University, 1961, Psychology; Sigma Xi; Kappa Phi Kappa; APA; EPA; AAAS; AAUP; RAS; KAF.

NIEHOFF, ARTHUR H., Senior Scientist; PhD, Columbia University, 1957, Cultural Anthropology; AAA; AS; WAA.

SMACKEY, THELMA R., Research Associate; MS, Georgetown University, 1963, Linguistics; AAUP; AAUW.

TAXIS, SAMUEL G., Senior Scientist; MA, George Washington University, 1965, International Affairs; USNI.

UPCHURCH, HARLEY M., Research Scientist; PhD, Louisiana State University, 1965, Sociology; ASA; ESA; SSS.

PROFESSIONAL MEMBERSHIP ABBREVIATIONS

AAA	American Anthropological Association
AAAA	Army Aviation Association of America
AAAS	American Association for the Advancement of Science
AAP	Association of Aviation Psychologists
AAPSS	American Academy of Political and Social Science
AATSP	American Association of Teachers of Spanish & Portuguese
AAUP	American Association of University Professors
AAUW	American Association of University Women
ABEP	American Board of Examiners in Psychology
ACM	Association for Computing Machinery
ADI	American Documentation Institute
AERA	American Educational Research Association
AFS	American Federation of Scientists
AHS	American Helicopter Society
Ala.PA	Alabama Psychological Association
AMS	American Men of Science
AOA	American Ordanance Association
APA	American Psychological Association
AS	Asia Society
ASA	American Sociological Association
ASCD	Association for Supervision & Curriculum Development
ASS	American Sociological Society
AStA	American Statistical Association
AUSA	Association of the US Army
CAREL	Central Atlantic Regional Educational Laboratory
CC	Cosmos Club
D.C.P.A.	District of Columbia Psychological Association
D.C.S.S.	District of Columbia Sociological Society
EIA	Electronics Industry Association
EM	Engineering Management
ENTELEK	Office of Naval Research Computer Instruction Interest Group
EPA	Eastern Psychological Association
FPA	Florida Psychological Association
GPA	Georgia Psychological Association
HFE	Human Factors in Electronics
HFS	Human Factors Society
HRB	Highway Research Board
IAAP	International Association for Applied Psychology
IEEE	Institute of Electronic and Electrical Engineers
IPA	International Plat-form Association
ISB	International Society Biometerology
KAF	Korean-American Foundation
KPA	Kentucky Psychological Association
LSA	Linguistic Society of America
MAA	Mathematical Association of America
Md.PA	Maryland Psychological Association
MGA	Military Government Association

MLA	Modern Language Association
MPA	Midwestern Psychological Association
NEA	National Education Association
NGA	National Geological Association
NHPA	New Hampshire Psychological Association
NRC	National Research Council
NSPI	National Society for Program Instruction
NSPRA	National School Public Relations Association
PGME	Professional Group in Military Electronics
PMS	Psychometric Society
PPA	Professional Photographers of America
PS	Psychonomics Society
PSA	Pacific Sociological Association
QB	Quiet Birdmen
RAS	Royal Asiatic Society
RMPA	Rocky Mountain Psychological Association
ROA	Reserve Officers of America
SEPA	South-Eastern Psychological Association
SIAM	Society for Industrial & Applied Mathematics
SGSR	Society for General System Research
SO	Society of the Optimates
SSPP	Southern Society for Philosophy and Psychology
SSS	Southern Sociological Society
STWP	Society of Technical Writers and Publishers
SWPA	South-Western Psychological Association
TAA	Transactional Analysis Association
TBPE	Texas Board of Psychological Examiners
TESOL	Teachers of English to Speakers of Other Languages
VPA	Virginia Psychological Association
WAA	Wisconsin Archeological Association
WCCSG	West Coast Conference for Small Groups
WLC	Washington Linguistics Club
WORC	Washington Operators Research Council
WPA	Western Psychological Association

2F. CENTER FOR RESEARCH IN SOCIAL SYSTEMS

Washington, D.C. 20016

1. Applied Research on Non-Materiel Factors in Low Intensity Conflict (Project No. 2J024701A714).

WORK UNIT NUMBER	EXPERIMENTER (WORK UNIT LEADER)	DATE STARTED	DATE COMPLETED
I. Preparation of U.S. Military Personnel for Assignments in Developing Nations	Dr. Arnold Dahlke	February 1967	Continuing

Research concerning preparation of U.S. Army officers for military advisory duty will provide insight into the problems involved in the increasing number of assignments given to the U.S. officer corps to advise indigenous counterparts in developing nations. The objectives of the study are to: (1) determine some of the major functions common to ordinary military officers assigned to advisory duty; (2) develop some general criteria for the selection, preparation and utilization of army officers in military advisory duty; (3) to develop broad guidelines for a rough model at a high level of aggregation for career patterns which would recognize the relative importance of advisory assignments, and adequately and relevantly permit the preparation of an officer in his normal training for such assignment.

In addition to research, this work unit includes the continuation of liaison activities at Fort Bragg, the locus of much of the military training for assignments in foreign areas.

II. Military Civic Action and Community Relations: Military and Cultural Implications	Dr. Norman Smith	July 1967	Continuing

This work unit will address itself to: (1) the development of a clearer understanding of civic action in terms of its definitions, objectives, programs, and effectiveness; (2) an empirical assessment of the effectiveness of civic action; (3) an examination of the effectiveness of one type of U.S. military community relations effort overseas.

The first study will develop working descriptions of the relationships mentioned above, i.e., definitions, objectives, programs, and effectiveness. Once these are established, criteria for assessing the effectiveness of military civic action programs can be identified and evaluated.

The second study will consider the effects of military civic action on the indigenous population (of Korea). One of the main objectives will be to test the adequacy of the criteria developed in the first study.

In the third study, knowledge derived from a recently completed descriptive review of community relations advisory councils will be used to develop an instrument for periodic assessment of relations among members of the community relations advisory councils.

As a part of the preceding activities, professional personnel will be available to assist in advisory services to Eighth U.S. Army staff officers.

WORK UNIT NUMBER	EXPERIMENTER (WORK UNIT LEADER)	DATE STARTED	DATE COMPLETED
III. U.S. Defense Operations in Military Assistance and Psychological Operations	To Be Determined	July 1966	Continuing

During FY68 CRESS proposes to undertake five specific studies within this work unit. One study is a continuation of ongoing efforts to produce a series of intercultural communication guides for specific countries designated by the U.S. Army based on a pragmatic research design. Another study will develop methodological guidelines to enable psychological operations officers to evaluate attitudes in localized areas overseas with a reasonable degree of accuracy despite limited availability of information. Concurrently, an exploratory study will

be conducted, designed to develop a more comprehensive and systematic program of research in the broad field of psychological operations, which will contribute to the integration of policy, communications, training, target analysis, and measurement-effectiveness aspects of the problem.

The fourth study will identify and analyze problem areas in the social systems of certain Communist and other countries so as to indicate new approaches to the neutralization of Communist subversive activities. The fifth study will identify myths and folklore of a specific culture and the applicability of these beliefs to psychological operations.

IV. Military Forces of Developing Nations	To Be Determined	January 1962	Continuing

This work unit consists of two in-house studies and four subcontracts with other universities (Chicago, Indiana, Florida, and Princeton). The first of the in-house studies started in FY 67 is intended to investigate attitudes of the civilian and military sectors of the populations of three very similar developing nations in a Latin American environment. A further study will determine the motivation of military personnel in developing areas to improve their capability for adequately using and maintaining U.S. Army equipment provided under the Military Assistance Program. Particular emphasis will be placed on (1) determination and assessment of present capability; (2) determination of potential, within a given social environment, for increasing that capability; and (3) determination of the motivation of country-specific personnel to achieve their capability.

WORK UNIT NUMBER	EXPERIMENTER (WORK UNIT LEADER)	DATE STARTED	DATE COMPLETED
V. Methodologies for Research on Foreign Cultures	To Be Determined	July 1966	Continuing

A major area of concentration in CRESS is work designed to increase understanding of foreign societies characterized by fundamental differences in patterns of living and culture. Three methodological studies are included in this work unit for FY68. The first is designed to increase the effectiveness of intercultural communications efforts by improving research capability to collect cultural and audience-specific information on foreign societies. The second is designed to develop a capability to measure the effectiveness of intercultural communications efforts by means of a new technique of opinion and attitude trend analysis. The third addresses itself to some problems and techniques associated with behavioral change during situations of national crisis.

VI. U.S. Operations in Unconventional Warfare and Internal Defense and Development	D. M. Condit	January 1963	Continuing

This work unit contains three major efforts. One project includes three in-depth studies--one concerning insurgent use of threats and terror, one concerning the role of the police in past insurgent situations, and one concerning development optimum police system. A second project involves the study of insurgent underground infrastructure and methods for combating it. The third study provides for analysis of a number of strategic factors involved in internal conflict situations across a wide variety of cases and four indepth studies of tactical factors rated as critical. All three projects in this work unit represent continuation, development, and refinement of past work.

WORK UNIT NUMBER	EXPERIMENTER (WORK UNIT LEADER)	DATE STARTED	DATE COMPLETED
VII. Social Processes Relevant to Military Planning for Stability	To Be Determined	September 1965	Continuing

Two studies are included in this work unit. One, a continuation from the previous fiscal year, focuses on the dyn[illegible]s of change in urban Africa. This study will seek to provide inf[illegible]tion concerning (1) African sociopolitical structures and dynamics; (2) leadership resources and attitudes; specifically, to describe and analyze three key leadership groups: the urban, the intellectual and the military. The second study will examine the applicability of social and behavioral science research to U.S. Army activities in developing countries. It is designed to (1) identify research projects relevant to Army activities and missions in the developing areas; (2) categorize these research studies according to the major fields of defined Army interest and its deployment of individuals, teams, and organized forces to assist in the developing of these areas in an atmosphere of order; (3) inventory the conclusions and recommendations of these research projects and organize them for use as a body of basic references; (4) draw from the studies thus aligned a tabulation of comparable conclusions and recommendations for use as a basis for formulating Army doctrine within the combat developments system; and (5) isolate those matters on which the highest priority should be assigned for further research or re-examination of completed research findings.

VIII. Cultural Information Analysis Center	Mr. James Price	July 1964	Continuing

The objectives of CINFAC are twofold: (1) to collect, store, retrieve, and synthesize available data and information pertaining to the human factors involved in the processes of modernization and social change in specified geographic areas of the world; (2) to provide rapid responses to request for analyses, syntheses and other user services concerning the available scientific and technical information of these areas.

CINFAC responds to requests from military and U.S. government agencies, as well as to qualified non-government institutions. Information is analyzed in terms of specific requirements and interests of the requestors.

2F. CENTER FOR RESEARCH IN SOCIAL SYSTEMS BIBLIOGRAPHY OF PUBLICATIONS SINCE LAST CONFERENCE REPORT

ASIA BRANCH, CINFAC. Bibliography of materials on selected groups in the Republic of Vietnam, Dec. 1966. DDC No. AD 643-989.

BITTICK, M., N. CURRIER, D. GOSIER, and H. BERRY. CINFAC Bibliographic review, supplement no. 10, Oct. 1966. DDC No. AD 642-362.

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ABBOTT, Preston S., Dr., Director, CRESS; B.A., Bates College, Psychology, 1947; M.A., University of Hawaii, Psychology, 1948; PhD, Brown University, Psychology, 1953; Fellow, APA, Sigma XI; Member, D.C. Psychological Association, Eastern Psychological Association.

ADANALIAN, Alice A., Research Scientist; B.A., Northwestern University Social Services, 1930; M.A., Teachers College of Columbia University, Psychology, 1934; Middle East/Africa; Member, African Studies Association, American Personnel and Guidance Association, Middle East Institue, American Political and Social Science Association.

ASKENASY, Alexander R., Dr., Senior Research Scientist; B.A., University of Wisconsin, Psychology, 1950; M.A., Princeton University, Psychology, 1954; PhD, Columbia University, Social Psychology, 1959; Psychological Operations; Member, American Psychological Association, Eastern Psych. Ass'n.

BITZ, Ira, Research Scientist; B.A., New York University, Political Science, 1964; Southeast Asia; Member, American Academy of Political and Social Science, American Sociological Association, American Political Science Association, Southern Political Science Association.

BRUMMITT, Leroy D., Division Planner and Programmer; B.S., University of Maryland, Military Science, 1960; M.A., George Washington University, International Affairs, 1961.

CARR, William K., Research Scientist; B.A., George Washington University, Psychology, 1947; M.A., Columbia University of New York City, Anthropology, 1957; China; Member, American Anthropological Association, Association for Asian Studies.

CLARK, Laurence H., Research Associate; B.A., Haverford College, Political Science, 1958; M.A., Harvard University, East Asia, 1966; Asia; Member, Japan-American Society of Washington.

CONDIT, Doris M., Senior Research Scientist; B.A., George Washington University, History, 1949; M.A., George Washington University, History, 1952; Unconventional Warfare, Internal Defense and Development; Member, American Historical Association, Operations Research Society of America.

CONLEY, Michael C., Dr., Senior Research Scientist; B.A., Ohio State University, History, 1950; M.A., Ohio State University, History, 1951; PhD, Ohio State University, History, 1960; Communist Organization and Practice; Member, American Historical Association.

COOPER, Bert H., Jr., Research Scientist; B.A., Furman University, Political Science, 1956; M.A., George Washington University, International Relations, 1961; Unconventional Warfare, Internal Defense and Development; Member, American Political Science Association.

COZEAN, Jon D., Research Associate; B.J., University of Missouri, Journalism, 1960; M.A., George Washington University, International Affairs, 1966; Latin America.

CROWE, Irene W., Research Assistant; B.A., Oxford University, England, Economics, 1966; Asia; Member, African Society, U.K.

DABNEY, Richard L., Research Assistant; B.A., American University, English, 1966; Communist Organization and Practice.

DAHLKE, Arnold E., Dr., Senior Research Scientist; B.A., University of Nevada, Psychology, 1959; M.A., University of Nevada, Psychology, 1960; PhD, University of Minnesota, Psychology, 1963; Military Career Problems.

DAME, Hartley F., Senior Research Scientist; Army Command and General Staff College, 1950; Army Language School, 1953; Latin America.

DURR, John C., Dr., Research Scientist; B.S., U.S.M.A. West Point, Military Science, 1946; M.A., Stanford University, History-Asia, 1952; PhD, Georgetown University, History-Asia, 1959; Asia

FALLAH, Skaidrite, Research Associate; B.A., Hunter College, 1960; M.A., Johns Hopkins, International Relations, 1962; Asia; Member, American Society of International Law.

FRANCES, Albert S., Dr., Senior Research Scientist; B.A., University of Madrid, History, 1942; L.D., University of Oviedo, Law, 1947; PhD, University of Pittsburgh, Sociology, 1967; Latin America; Member, American Sociological Association.

FROMME, Marilou, Research Assistant; B.A., American University, English Literature, 1963; Asia.

HANNA, Judith L., Research Scientist; B.A., University of California, Political Science, 1958; M.A., Michigan State University, Political Science, 1962; Africa; Fellow, African Studies Association; Member, American Anthropological Association, American Political Science Association.

HANNA, William J., Dr., Senior Research Scientist; B.A., University of California, Political Science, 1957; M.A., University of California, Political Science, 1960; PhD, University of California, Political Science, 1962; Africa; Member, African Studies Association, American Academy of Political and Social Science, American Psychological Association, American Sociological Association.

HESSLER, Albert H., Research Scientist; B.A., Antioch College, Sociology, 1954; M.A., State University of Iowa, Sociology, 1963; M.A., State University of Iowa, Labor and Management, 1965; Asia; Member, American Sociological Association.

HITT, Deborah S., Research Assistant; B.A., Newcomb College of Tulane University, Psychology, 1966; Latin America.

JONES, Adrian H., Research Scientist; B.S., University of Maryland, Military Science, 1956; M.A., University of Kansas City, Psychology, 1962; Military, Paramilitary and Civil Security; Member, American Psychological Association, American Sociological Association, Society for General Systems Research.

JUREIDINI, Paul A., Senior Research Scientist; B.A., American University of Beirut, Political Science, 1955; M.A., University of Virginia, International Affairs, 1961; Middle East/Africa.

KRYMIS, Karen R., Research Associate; B.A., Michigan State University, Political Science, 1964; M.A., Stanford University, Hispanic American Studies, 1965; Latin America.

LaCHARITE, Norman A., Research Scientist; B.A., American University, International Relations, 1959; M.A., American University, Soviet Area Studies, 1963; Military, Paramilitary and Civil Security; Member, American Political Science Association.

LYSNE, Dale A., Research Assistant; B.A., Concordia College, Math, 1959; M.A., American University, Russian Language and Literature, 1967; Intercultural Communications; Member, National Education Association, HATSEEL.

MANEE, Walton C., Research Associate; B.S., University of Maryland, Military and Political Science, 1954; Asia.

MARTIN, Dolores M., Research Associate; B.A., Vassar College, English, 1956; Latin America.

MOORE, Richard H., Executive Director, CRESS; B.A., University of Michigan, Business Administration, 1932; M.A., University of Michigan, Business Administration, 1933; Army Command and General Staff College, 1950; Army War College, 1954.

MURPHY, Elaine M., Research Assistant; B.A., Vassar College, Art and History, 1963; Middle East/Africa.

MYERS, Raymond W., Research Assistant; B.A., American University, International Relations, 1965; M.A., American University, Far Eastern Studies, 1967; Asia.

PAOLOZZI, Ursula M., Research Assistant; Certificate, Alliance Francaise, French, 1938; Dollmetcher, University of Heidelberg, French, 1940; Launea, University of Perugia, Political Science, 1942; Middle East/Africa.

PETERS, Stephen, Research Scientist; B.A., Harvard College, English and History, 1934; M.A., Harvard Graduate School of Education, English and Education, 1936; Communist and World Movement; Member, U.S. Foreign Service Association.

POLLOCK, Daniel C., Senior Research Scientist; Certificate, San Diego State College, Public Administration, 1934; Southeast Asia.

PRICE, Barton B., Research Associate; B.A., Northeastern University, Psychology, 1965; M.S., Boston University, Communications, 1967; Military, Paramilitary and Civil Security.

PRICE, James R., Division Planner and Programmer; B.A., University of Alabama, Political Science, 1949; M.A., Johns Hopkins University, International Relations, 1950.

SCHROCK, Joann L., Research Associate; B.A., American University, International Relations, 1963; Asia.

SILVERBURG, Sanford R., Research Assistant; B.A., Sinea College, History, 1962; Middle East/Africa; Member, Middle East Institute, Middle East Studies Association of North America.

SMITH, Norman D., Dr., Senior Research Scientist; B.A., Phillips University, Psychology, 1958; PhD, Oklahoma State University, Psychology, 1964; Civic Action; Member, American Psychological Association, American Anthropolotical Association.

SMITH, Ray B., Dr., Research Scientist; B.A., University of Texas, Pre Medical, 1956; M.A., University of Texas, Educational Psychology, 1957; PhD, University of Texas, Psychology, 1967; Psychological Operations.

SMYSER, Willis M., Dr., Research Scientist; B.A., Gettysberg College, Education, 1936; M.A., Georgetown University, International Relations, 1949; PhD, Georgetown University, International Relations, 1949; Latin America.

SPINKS, Charles N., Dr., Senior Research Scientist; B.A., Stanford University, History and Political Science, 1929; M.A., Stanford University, History, 1930; PhD, Stanford University, History, 1936; Southeast Asia; Member, U.S. Foreign Service Association, Japan-America Society, Siam Society, Asiatic Society of Japan.

STEGEMAN, Patricia L., Research Assistant; B.A., American University, Political Science, 1967; Asia.

STOWELL, John H., Research Scientist; B.S., University of Rhode Island, Economics, 1936; Southeast Asia.

SWISHER, Ralph B., Research Scientist; B.A., Idaho State University, Political Science, 1950; Civic Action; Member, American Political Science Association, Society for International Development.

SZALAY, Lorand B., Dr., Senior Research Scientist; PhD, University of Vienna, Psychology, 1961; Intercultural Communications; Member, American Psychological Association, American Academy of Political and Social Sciences, American Sociological Association.

TERAUDS, Anita, Research Associate; B.A., George Washington University, Psychology, 1959; Asia.

TIMS, Frank M., Research Scientist; B.A., University of Alabama, Sociology, 1963; Civil Affairs; Member, American Sociological Association.

TRINNAMAN, James E., Jr., Research Scientist; B.A., Hobart College, Political Science, 1956; M.A., Johns Hopkins University, Political Science, 1960; Intercultural Communications; Member, American Political Science Association.

WATSON, Frances M., Jr., Research Scientist; B.S., University of Georgia, Education, 1958; M.A., University of Georgia, Journalism, 1959; Social Science Research Liaison, Special Warfare Center.

WILSON, Barbara A., Research Associate; B.A., Beloit College, Political Science, 1963; M.A., American University, African Area Studies, 1965; Middle East/Africa.

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